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CRN SC 021

**Specification**

# Cable Routes and Associated Civil Works

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# Document information

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# Document history

| Revision | Effective date | Summary of changes |
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| Version 2.4 | 30 January 2022 | TfNSW template applied. |
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# 1. Scope and application

This Standard establishes design requirements, approved configurations, and installation requirements for the following elements of signalling infrastructure:

- main and local signalling, communications and power cable routes, including buried routes, ground level troughing (GLT) and above ground troughing (GST),
- cable pits, jointing pits and cable turning chambers
- foundations for signals, gantries, location cases, ground frames
- bootleg risers and mounting posts for trackside track circuit equipment
- mounting of miscellaneous signalling equipment

It contains significant reference to work undertaken to meet requirements of CRN CS 540 in particular.

This standard is applicable to all Country Regional Network (CRN) infrastructure.

It also contains the procedure for Buried Service Searches (See Appendix 1).

## 1.1. Definitions and abbreviations

Definition of terms used in this document is found in the glossary in CRN Standard CRN SG 001 Glossary of Signalling Terms.

The following additional definitions apply in this standard.

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| **CRN** | Country Regional Network, the geographic area in New South Wales where the rail infrastructure referred to in this Standard is located. |
| **Access Road** | Any track or roadway within the CRN rail corridor other than the defined entrance/exit roadway to a station, goods yard or compound or easement for access to property owned by others. |
| **Armoured Cable** | A cable that incorporates a steel wire armouring (SWA) layer around the outermost portion of the cable. The SWA layer is covered with a layer of insulating material such as V.90 and/or a sacrificial sheath. |
| **Backfill** | Compactable material free of rocks that will not pass through a 50mm sieve and free of broken concrete, brick, rubble, wood, glass, rubbish, steel or other metal objects that could damage cables or affect the operation of electronic cable locators. |
| **Ballast** | Material in accordance with CRN CS 240. |

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| **Bootleg riser** | For the purposes of this standard only)<br><br>A small termination box mounted on a 50NB hollow steel post or pipe with a steel or concrete base. |
| **Cable Ploughing** | The process of installing cable/s and the protective system using a mechanical ploughing device. |
| **Cable Route** | Any material installed or excavation carried out for the installation of cables between two points. |
| **External Cable Route** | Cable route not in a building. |
| **Internal Cable Route** | Cable route inside a building. |
| **Local Cable Route** | (also called local route)<br><br>Any cable route, which does not fall into the category of main or internal cable route. |
| **Main Cable Route** | (also called main route)<br><br>Any external cable route, which contains or is intended to contain at least one main cable. |
| **Clean Fill** | Sand (or soil) that is free of stones, rocks, wood, metal and rubbish. |
| **Cables** | |
| **Main Cables** | Any cables, which are run from a cable termination point in one building, equipment room or location case to a cable termination point in another building, equipment room or location case. Note that joints in cables including those for loading and balancing purposes do not constitute a termination of the cable for the purposes of defining main cables. |
| **Local Cables** | All cables that are not main cables. |
| **Signalling Cables** | Cables to signals, points, ground frames, releasing switches, level crossings, buffer stop lights, guards indicators etc. plus cables between equipment rooms and between equipment rooms and location cases. |
| **Track Circuit Cables** | Cables from the equipment room or location case to the bootleg riser or to the trackside equipment boxes in the case of the Jeumont Schneider high voltage impulse and the audio frequency track circuits plus cables from the Jeumont Schneider and the audio frequency track circuit trackside equipment to the track. |
| **Communications Cable** | All main and local communications cables including communication cables to station buildings, relay rooms, location cases, trackside telephones, etc. |

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| **Cover Strip** | The strip (or layer) of recycled plastic protective material placed over buried cables. |
| **GLT** | Ground level troughing (refer to Section 5.5) |
| **GST** | Galvanised Steel Troughing (refer to Section 5.6) |
| **High Voltage** | (For the purposes of this standard only)<br>Any voltage greater than 120 volts (nominal). |
| **Location Case** | (also called location cupboards or locations)<br>Signalling equipment cupboards or housings that are not buildings. |
| **Low Voltage** | For the purposes of this standard only)<br>120 volts (nominal) or less |
| **Stabilised Sand** | A mixture of sand and Portland cement in the ratio 10:1. |
| **Structures** | (For the purposes of this standard only)<br>overbridges or underbridges, road, rail or pedestrian bridges, retaining walls, parapet walls and platforms. |
| **Track Plan** | (also called Signalling Plan or Signalling Scheme Plan)<br>Plan showing general signalling arrangements. |
| **ULX** | Under Line Crossing |
| **URX** | Under Road Crossing |

# 2. Engineering Authority

Design, selection and installation of signalling infrastructure detailed in this standard for use on the CRN may only be undertaken by persons who have been granted appropriate Engineering Authority by the Principal Signals Engineer.

The Principal Signals Engineer has authorised local Signal Engineers to arrange any inspection or submission for review, consideration acceptance or approval before further work is to be carried out on any product, process or installed work and to authorise and direct action related to the works.

Design and installation of civil works, detailed in this standard for use on the CRN may only be undertaken by persons who have been granted appropriate Engineering Authority by the Principal Track and Civil Engineer.

# 3. Planning requirements

## 3.1. Site Surveys

Detailed site surveys shall be carried out during the project planning phase to determine locations for infrastructure equipment to be installed.

All site works shall be executed in accordance with approved detailed site survey drawings, installation drawings and notes etc.

## 3.2. Signal sighting forms

The location of all signals, indicator signals, guard's indicators etc., shall be documented on signal sighting forms, which, together with full details and information, shall be reviewed and confirmed in a survey of each site by UGLRL personnel and representatives of train operators and signalling system designers. Signal sighting forms with signatures of all parties shall then be used as a primary input to the design.

## 3.3. Location of buried services

All buried services on the proposed cable route shall be located in accordance with the requirements of Appendix 1. The completed "Excavation and Trenching Permit" shall be utilised as part of the design process to locate the cable route and during the installation phase.

## 3.4. Agreements

Where cable routes cannot be located within the railway corridor, agreement shall be reached with the owners of land affected by the proposal or with Local or Public Authorities. Such agreements shall be approved by UGLRL.

In such instances the design drawing shall show the land owner's name and the deposited plan and folio numbers pertaining to the land.

The agreement shall also include:

- permission for CRN access in future years for cable renewal/repair.
- any special conditions of entry.

Where an existing buried service will be affected by the proposed cable route, agreement shall be reached with the owners of land affected buried service's owner/s and UGLRL regarding the method of crossing the affected service.

# 4. Design requirements

All work shall be undertaken in accordance with approved designs. The following requirements shall be considered during the design process:

## 4.1. Protection of the environment

The design and installation of cable routes, including the replacement of components in existing routes, shall take into account environmental impacts during construction and maintenance activities, with a view to minimising any impacts.

All work shall be undertaken in accordance with the requirements of HSE Risk Management Procedure UGLMS-1655521379-484.

The following requirements shall apply:

1. All cable routes shall be designed to be as unobtrusive as possible, both to reduce its visual impact on its surroundings and to avoid drawing attention to the presence of copper cable.
2. The route shall not be attached to, or alter the appearance, of any building or structure that is on a heritage list or is subject to a preservation order without specific approval from the relevant heritage authorities.
3. Trees or shrubs shall only be removed or lopped to the least extent necessary for construction of the route. Care shall be taken not to damage the root systems of mature or substantial trees.
4. During the construction of trenching for buried cable route or ground level ducting, care shall be taken to prevent silt runoff into any waterway and to prevent blockage of any natural or track drainage.

## 4.2. Location of equipment

The position of all equipment adjacent to the track shall comply with the clearance requirements specified in CRN CS 215.

Where current standards cannot be achieved the approval of the Principal Track and Civil Engineer shall be obtained.

## 4.3. Signal Location

Signals shall be located in accordance with the requirements of CRN SC 015.

Where signals cannot be located adjacent to the track in the correct position due to the closeness of adjacent tracks or some other obstruction, the requirements of CRN SC 015 shall apply.

Each signal shall be positioned in relation to rail level and shall be given a kilometrage or a distance from a well-defined structure such as a bridge, platform or gantry.

## 4.4. Existing equipment

Where existing signalling infrastructure inhibits the installation of new equipment, the design documentation shall include determination of appropriate action. This action may include:

- temporary work, or
- relocation of the new equipment.

## 4.5. Supply of materials

### 4.5.1. Materials

All materials and equipment used in the works shall comply with the requirements of CRN SC 007 to CRN SC 013 inclusive.

In particular, no cable shall be installed unless the cable manufacturer's factory test results have been sighted and approved.

### 4.5.2. Painting/finish of metal surfaces

All steel components or constructions shall be proofed against corrosion by a process, which will provide a minimum service life of 30 years in the environment in which the components or constructions are installed.

In selecting the process to be used, the likelihood of minor damage during installation such as scrapping, scratching and chipping shall be taken into account.

Painted or powder coated finishes are not acceptable as the primary corrosion proofing process in external applications, but may be used to provide additional protection in those instances or locations where the primary process cannot provide the specified service life.

Fasteners used externally to buildings shall be either plated or of a material that will provide the specified life. (Note: If stainless steel nuts are used on stainless steel fasteners, an anti-seize product shall be used between nut and bolt).

For applications within buildings, except in wet areas such as cable pits, the level of protection may be reduced to zinc plating or equivalent.

Painting of galvanised (or equivalently plated) steel, stainless steel and aluminium metalwork is not to be undertaken.

Where a paint finish is specified, powder coating, enamel, epoxy coatings or acrylic lacquer finishes may be used. The metal shall be surface cleaned, etched, primed, undercoated and finished in accordance with the paint manufacturers' recommendations.

Finish colour of painted surfaces shall be compatible with the environment in which they are located.

### 4.5.3. Alternative materials, products or processes

Where this standard proposes a particular material, product or process or range of materials, products or processes, alternatives may be accepted for use where they have received type approval in accordance with the requirements of CRN SC 014. “Type approval requirements for signalling systems and equipment”.

## 4.6. Specific design requirements

The following items shall be documented in the design:

### 4.6.1. Signalling issues

**Cable route**

Details of the cable route, including:

- Location of main cable route (See Section 5.1)
- Changes between route type (See Section 5.7.3)
- Justification for selection of cable route types (See Section 5.3)
- Location of local cable routes

**Cables**

- cable size in the main cable route to provide approved capacity (including a minimum of two spare cores or 10% spare cores in each cable, whichever is the greater).
- the form of permanent and unique identification for application on each end of every length of cable. Cable identification codes shall be in a standard approved format.

- details of re-enterable fire resistant material for use in sealing all cable entries to location cases and small buildings.

**Buried route**

- Depth of route, including justification for non-standard depth (See Section 5.4.1)
- Details of protective cover strip, including where installed (See Section 5.4.3).
- Earth wire details and location where applicable (See Section 5.4.4).
- Location of cable marker tape (See Section 5.4.5)
- details placement of cable in shared trenches (See Section 5.1.5)
- Details relating to the selection of pipe material, size, number and placement, including spare capacity (See Section 5.4.6).
- Details of the extent of the earthing arrangements around each high voltage installation (See Section 5.4.6.2)
- Details of method of crossing existing buried services (See Section 5.4.8).
- Location of cable route markers (See Section 5.4.9).

**For GLT**

- Details relating to the selection of troughing material, size, number and placement, including spare capacity. (See Section 5.5).
- Details of all direction changes. (See Section 5.5).
- details of placement of cables in shared troughing (See Section 5.1.5)

**For GST**

- Details relating to the selection of troughing material, size, number and placement, including spare capacity. (See Section 5.6.1).
- Details of all support posts including calculation of the capacity of cable ladder and support system if support centres are proposed to exceed specified requirements (See Section 5.6.2).
- Details of all fixings to structures, rock faces and walls (See Section 5.6.2).
- Details of transitions with GLT, buried route, ULX/URX, pits and location cases (See Section 5.7.3).
- details of placement of cables in shared troughing (See Section 5.1.5)

**For cable ladders**

- Details relating to the selection of ladder material, size, number and placement, including spare capacity. (See Section 5.7.1).

- Details of bends, joints, cable attachment and ladder covers. (See Section 5.7.1).
- Details of ladder support, including calculation of the capacity of cable ladder and support system if support centres are proposed to exceed specified requirements (See Section 5.7.2).
- Details of transitions with other ladder configurations, GST, GLT, buried route, ULX/URX and pits (See Section 5.7.3).

**Steel pipe cable route**

- Details of the location and attachment of galvanised pipe cable route on platform coping walls (See Section 5.8).

**ULX and URX crossings**

- Design details of ULX and URX crossings (See Section 5.9).

**Cable pits (See Section 5.10)**

- The location of all cable pits, cable jointing pits and cable turning chambers.
- Pit details including lids, floors and ladders

**Signals and gantries (See Section 5.11.1)**

- The location of the foundations for signals and signal gantries (including the distance from and height above rail).
- Signal installation including ATP pit, ladder base and conduits
- Cable routes on gantries
- Details of proposed locations of telephones at signals and signal gantries for drivers' use in case of emergency or during delays or interruptions to railway traffic.
- Details of proposed access to signals and signal gantries from public roads at locations where railway lines run alongside public roads. This shall include the provision of walkways/steps/handrails as necessary for safe and convenient access in addition to the provision of a lockable single width gate in the boundary fence in accordance with the requirements of Section 5.12.3.

**Location cases (See Section 5.11.2)**

Design details of location case foundations and platforms, including:

- a specific foundation design for sloping or unstable sites
- raised metal platforms where required
- Fixed steps or ladders
- Cable entries to location cases on raised platforms

- Details of access, including paths, steps and handrails, to all location cases

**Communications cable termination cabinets (See Section 5.11.3)**

- Design detail of foundations for communications cable termination cabinets.

**Track circuit equipment (See Section 5.11.4)**

- design and installation details of cabling and supports for track circuit equipment.

The following design details shall also be included:

- installation of bootleg risers not meeting the requirements of Section 5.11.4.2
- posts used for mounting high voltage impulse and audio frequency track circuit trackside equipment and boxes (See Section 5.11.4.3)
- releasing switch mounting posts and ground frames (See Section 5.11.5.1 and 5.11.5.2)
- Releasing switch name plate brackets and name plates
- cabling and supports for miscellaneous trackside equipment (See Section 5.11.5)
- Special design requirements for Guard's indicator mounting posts (See Section 5.11.5.6)
- details for cabling to platform and concourse indicators (See Section 5.11.5.7)
- details for cables to station buildings for local signalling control panels, telephones, etc. (See Section 5.11.5.8).
- foundations for and cabling arrangements to traffic huts. (See Section 5.11.5.9).
- Telephone mounting posts and associated cabling. (See Section 5.11.5.10)

## 4.6.2. Civil issues

- design of buried pipe trenches through watercourses (See Section 5.4.7)
- method/s of attachment of GST cable route to the structures of bridges and viaducts, tunnel walls, rock faces and retaining walls (See Section 0).
- design details of purpose designed structures to support GST. (See Section 0).
- Justification for attachment of GST cable route and cable ladders in tunnels and through underbridges. (See Section 0).

- details of signal post holding down bolt installations where they are proposed for installation in areas of solid rock. (See Section 5.11.1.2).
- design calculations for signal gantry foundation installations (See Section 5.11.1.3).

- track drainage arrangements where proposed cable route, signal or gantry foundations, pits or other structures will obstruct existing track drainage.
- design details of any minor building works (See Section 5.12.1)
- details of any access roads (See Section 5.12.2)
- details of any fencing and gates (See Section 5.12.3)
- design details for any retaining walls (See Section 5.12.5).

# 5. Approved configurations

## 5.1. Cable Route: General Requirements

### 5.1.1. Location of the Cable Route

The setting out and the construction of the cable route shall be in accordance with the provisions of this standard CRN CS 540 and HB 29 2007 “Communications Cabling Handbook”, with CRN CS 540 taking precedence at all times.

Except as otherwise specified in the design, the main cable route shall be located as follows:

- The route shall be on one side of the track (except where there are four tracks or more, in which case the route may be split to run down each side when convenient)
- The track shall be crossed the least possible number of times.
- Cable route shall, so far as possible, follow a constant grade and line. Rough and uneven ground shall be levelled to the extent necessary to achieve this objective.
- Local cables from housings to equipment shall be laid in the main cable route, except where required to leave the main cable route to access the equipment.
- Local cable routes shall be as direct as possible and at 90° to the track.
- The cable route shall be located as near as possible to the CRN rail corridor boundary. The preferred locations for cable routes are in Figure 1, Figure 2 and Figure 3 below.

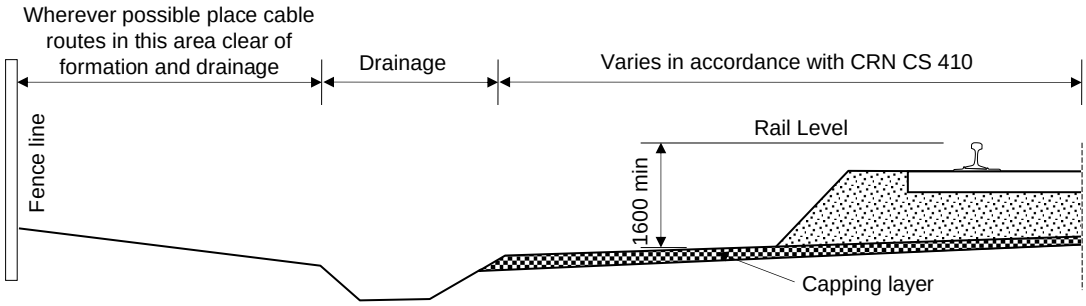



**Figure 1: Preferred cable route location – on level ground**

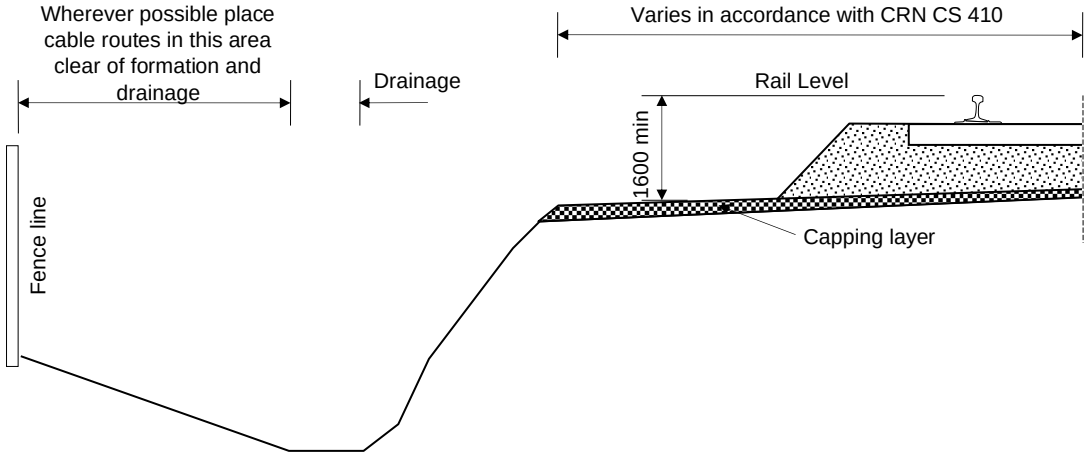



**Figure 2: Preferred cable route location – on embankments**

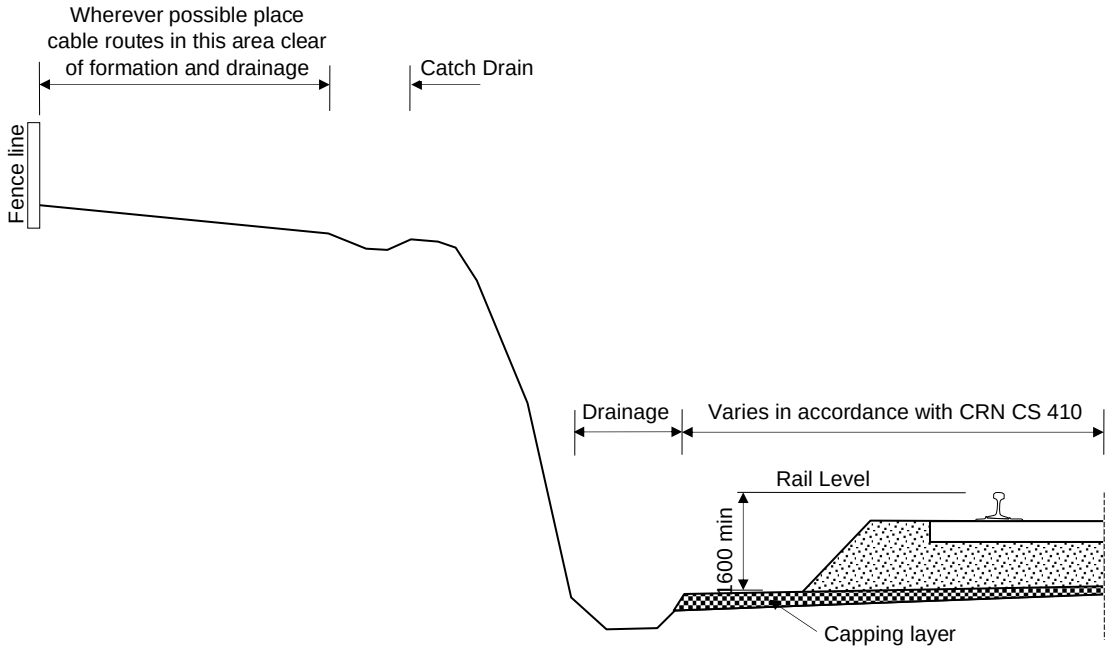



**Figure 3: Preferred cable route location – in cuttings**

- The minimum distance from the running face of the nearest rail to the cable route shall be not less than four (4) metres.
- Cable routes shall be parallel to the running lines wherever possible.
- The cable route shall be located and installed so that it does not divert or interfere with any drainage (railway or natural) or buried services.
- On level ground or embankments, where the ground continues to fall away from the formation, no allowance need be made for drainage.
- Special care shall be taken to ensure that the route will not affect the stability of any embankment or cutting.
- In cuttings where the catch drain is not required, the route may be laid 750mm from the top if in GLT or 1200mm if it is a buried route
- Where large waterways, gullies or roadways under tracks are encountered the cable route may be fixed to an available bridge structure. The installation design shall be in accordance with CRN CS 310.
- For small creeks and occasional waterways the cable installation design shall meet the requirements of CRN CS 540.
- Cable routes shall, where possible, be on the side of the tracks not occupied by high voltage earthed locations such as sub-stations, power sectioning huts and transformer locations.
- Cable routes under roadways shall be installed within the CRN rail corridor whenever possible.
- GST may be attached to rock faces where approved by the Principal Track and Civil Engineer.
- GST may be mounted in tunnels and through underbridges where clearances are limited at low level or where the troughing would interfere with access to refuges. The installation design shall be in accordance with the requirements of CRN CS 330.
- If the required clearances cannot be obtained using GST in a limited clearance area, cable ladders may be used to carry the signalling, communications and power cables.
- GST supports may be fixed to retaining or other walls
- The smallest radius bend in any cable route shall not be less than the manufacturer's recommended minimum radius for the largest cable to be installed in that route.

### 5.1.2. Underline crossings (ULX) and under-road crossings (URX)

The design of underline and under-road crossings shall meet the requirements of CRN CS 540.

### 5.1.3. Cable Pits

Cable pits, cable jointing pits and cable turning chambers shall be provided in accordance with the provisions of Section 5.10.

### 5.1.4. Cable routes on embankments

The location and method of installation of cable routes up or down embankments shall be designed to meet the requirements of CRN CS 410.

### 5.1.5. Cable placement

In buried cable route, ULX or URX, cables shall be placed as follows:

- main cables shall be laid in first so that they are deepest within the trench or pipework.
- Communications cables shall then be installed in the shallowest pipes.
- long series bonds (longer than 8 metres) shall be laid in the main or local cable trenches and terminated at each end in bootleg risers.
- Cables shall be arranged to permit easy access for the installation of additional cables in the future.

In ground level troughing (GLT):

- Communications cables shall be in a separate compartment within the GLT except where the communications cable is housed in a pipe or duct in which case it may be in the same compartment as signalling and low voltage cables.
- High voltage power cables shall be in a separate compartment to all other cables

In above ground troughing (GST):

- high voltage power cables shall be in a separate trough to all other cables
- Communications cables shall be in a separate trough.

## 5.2. Types of cable route

The following types of cable routes are approved for use on CRN infrastructure:

Type 1 Cable (excluding communications cable) buried directly in the ground. (See Figure 4)

Type 1a SWA cable (excluding communications cable) buried directly in the ground. Where HV cables are installed a suitable cover strip shall be installed even if HV cables are SWA (See figure 5)

Type 2 Cable (excluding communications cable) buried directly in the ground with one spare pipe buried over the cable to be accessed in future if required. (See Figure 6)

Type 3 Cable (excluding communications cable) buried directly in the ground with one or more pipes buried over the cable and pits at regular intervals. (See Figure 6)

Type 4 Cable buried in pipes with pits at regular intervals. (See Figure 7)

Type 4a Cable buried in pipes, where the number of used pipes is one, with one spare with pits installed as necessary to facilitate the pulling in of cables, where the number of cables is 4 or less.

Type 5 Ground Level Troughing (GLT), heavy wall type concrete. Alternatively "RAILDUCT 2000" HDPE or equivalent ducting for areas where vehicles do not have access.

Type 6 Galvanised Steel Troughing on posts or brackets (GST).

Type 7 Galvanised Steel Ladder on Wall.

Type 8 Aluminium Ladder on Wall.

Type 9 Stainless Steel Ladder on Wall.

Types 3 to 9 inclusive are classed as "re-enterable" cable route.

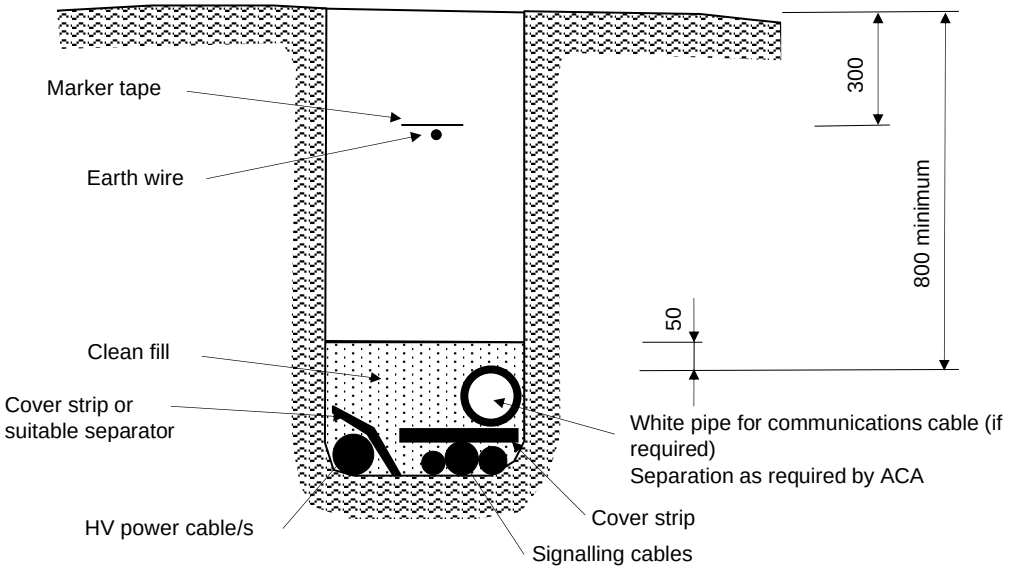



**Figure 4: Type 1 Cable Route**

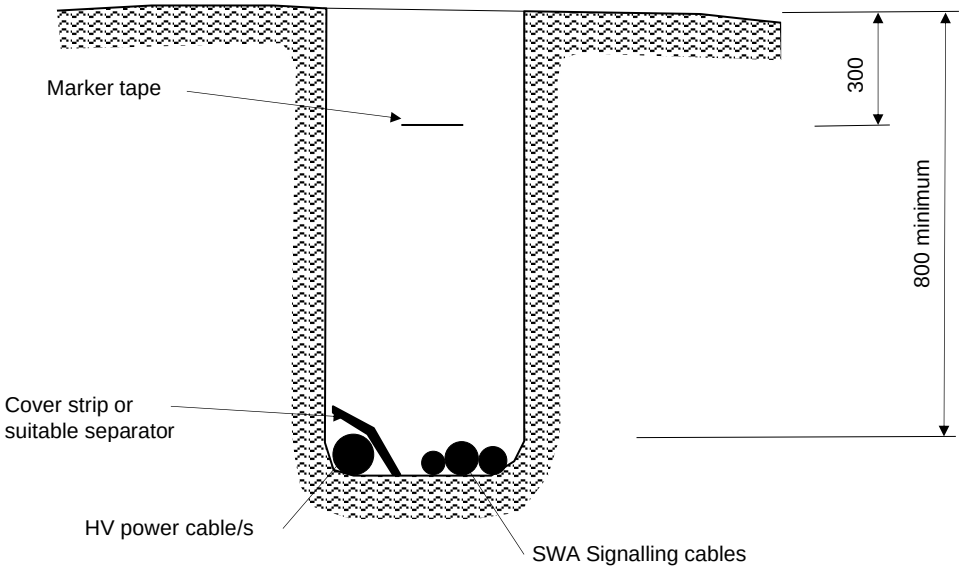
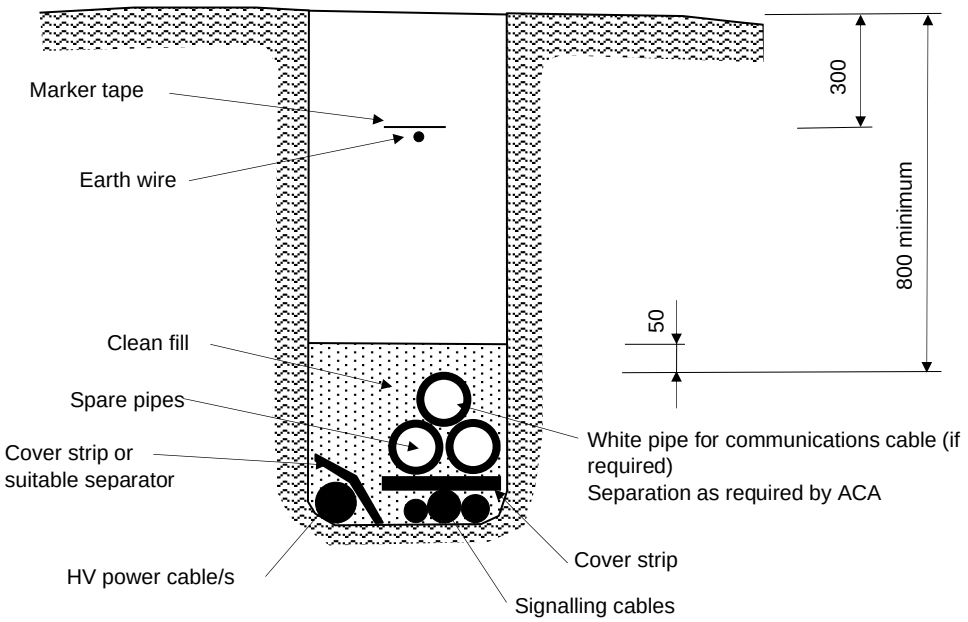



**Figure 5: Type 1a Cable Route**




Type 2 Cable Route without pits

Type 3 Cable Route with pits at 250m intervals

**Figure 6: Type 2 and Type 3 Cable Routes**

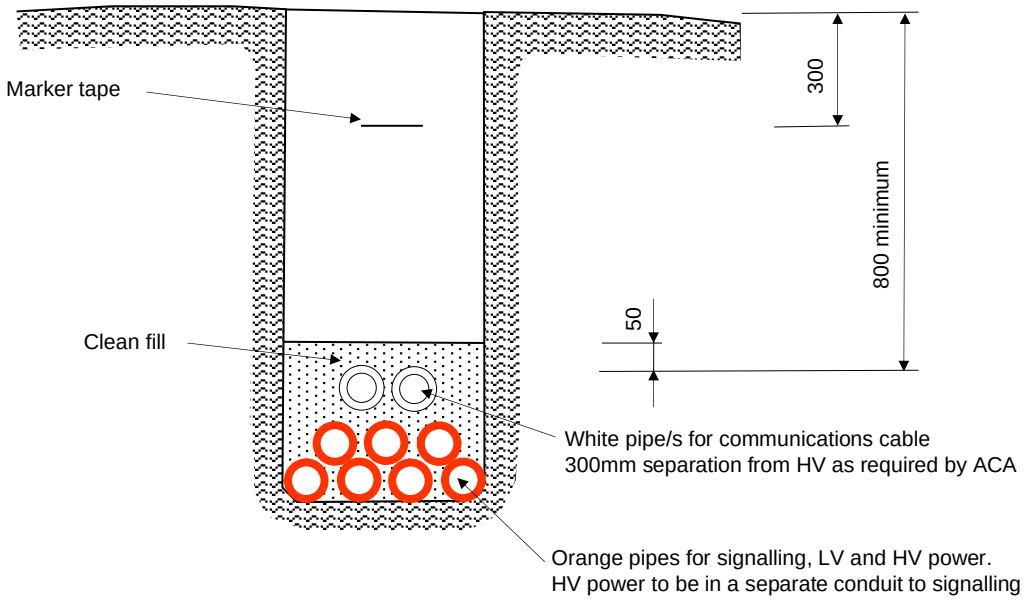



**Figure 7: Type 4 and 4a Cable Route**

## 5.3. Selection of cable route type

Where cables are buried through platforms cable route Type 4 shall be the preferred route. Other route types may be used with the approval of effected stakeholders.

Cable ladder may be provided where clearance limitations prevent the installation of GST or other types of cable route, such as in tunnels and along platform walls.

Steel pipe cable route shall be only be used where there is no alternative and, unless otherwise documented in the design, only for local cable route.

Specific requirements for the different types of cable routes are detailed in the following sections.

## 5.4. Buried cable route: Types 1, 2, 3 and 4

### 5.4.1. Depth of cable route

- The minimum cover over all buried services from the top of the cable/s or cover strip or topmost pipe to ground level shall be 800mm.
- Where 800mm cover cannot be achieved, reduced cover may, in the following circumstances, be approved:
  - The depth of cables in rock and shale areas shall be at least 600mm from ground surface to top of cable/s or cover strip or pipe,
  - in areas of unbroken rock a reduction in depth to 300mm may be permitted.
- In rock areas, the cables shall be laid on a bed of sand 100mm thick. (See Figure 8)

- The final 150mm of fill of trenches in rock areas shall be stabilised sand, or concrete if in vehicle access roads.
- The top of cables buried in the track formation shall be a minimum of 1600mm below rail level.

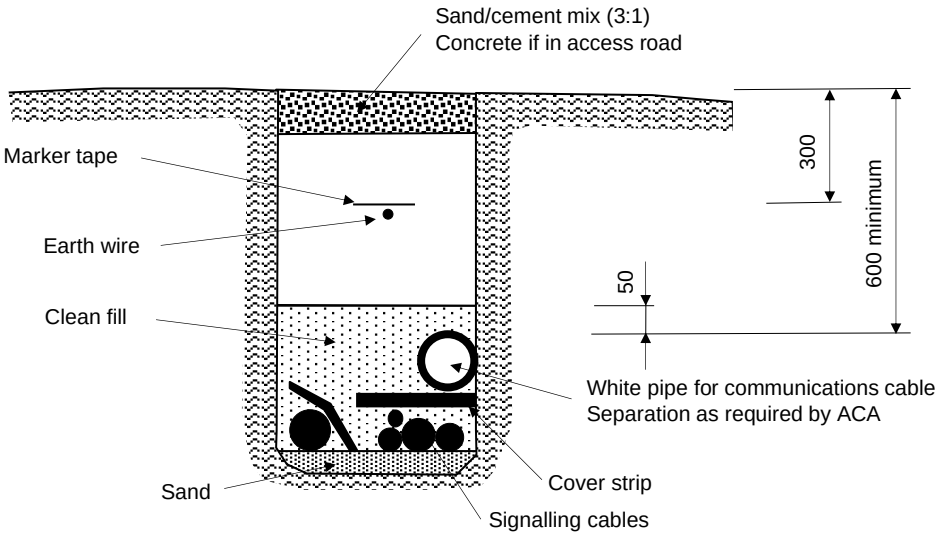



**Figure 8: Buried cable in rock**

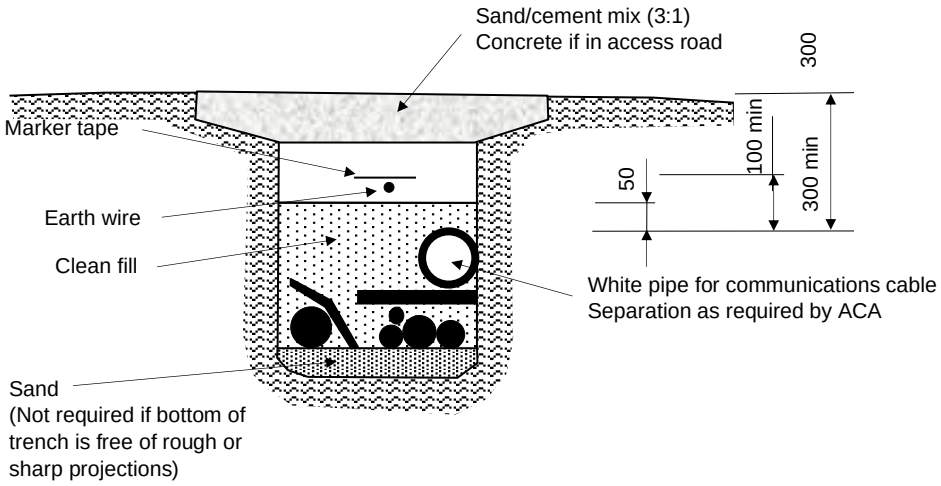



**Figure 9: Buried cable chased in unbroken rock**

## 5.4.2. Shared trenches

Where communications cables are in the same trench as signalling and power cables:

- Communications cables shall be housed in pipes
- The minimum separation between communications cables and signalling and power cables shall be as specified in HB 29 2007.

- The communications cables shall be above the signalling and power cables for the total length of run

### 5.4.3. Protective cover over signalling and communications cables

To provide mechanical protection to signalling, communications and power cables a separate cover strip covering all the cables (minimum cover width of 150 mm) shall be installed. The cover strip shall be placed on top of the cables and overlap the cables by not less than 50 mm on each side as shown in Figure 4.

SWA cables provide their own mechanical protection and when direct buried shall not require the separate cover strip.

### 5.4.4. Earth cables and wires in trenches

Stainless steel earth wires shall only be installed in cable trenches where the cable trench is located within 5000m of an electrified railway.

At a distance midway between location cases or buildings a 10 metre long gap shall be provided between the ends of the earth wires.

Earth wires in trenches shall not be located within 20 metres of any high voltage earth installation.

### 5.4.5. Cable marker tape

- 150mm wide orange coloured PVC marker tape with the wording:

  **"DANGER ELECTRICITY CABLES"**

- shall be installed 300 mm below ground level in all trenches as shown in Figure 4, Figure 5, Figure 7, Figure 7, Figure 8 and Figure 9.
- Where cables are permitted in shallow trenches due to rock, etc. the depth of the marker tape may be reduced to not less than 100mm above the protective cover.

### 5.4.6. Buried pipes

#### 5.4.6.1 General

Pipes may be rigid UPVC, 'HD Coreflo' or HDPE jointed using the manufacturer's recommended jointing methods.

The wall thickness (or class) of pipe shall be sufficient to guarantee that there will be no loss of cross sectional area and that there will be less than 10% loss of diameter in any direction during or after backfilling, boring, ploughing or pulling.

The minimum diameter of pipes shall be at least three (3) times the outside diameter of the cable to be pulled through the pipe with a minimum of 50mm diameter.

The diameter of pipes in a main cable run shall be 100mm diameter.

The number of pipes to be provided in ULX's, URX's and under access roads will depend on the cable route requirements in that area but provision shall be made for the following, as applicable.

- Signalling and power cables shall be in separate pipes to communication cables.
- High voltage cable shall be in a separate pipe to signalling or communications cable.
- Each 11Kv or 33Kv cable shall be in a separate pipe
- Unless otherwise approved, optical fibre cable shall be in a separate pipe.

### 5.4.6.2 Pipes in high voltage areas

Where communications cables are required to be run into high voltage earthed locations such as sub-stations, power sectioning huts and transformer locations, they shall be looped into and out of the locations and be protected by pipes. The conditions stated in Section 6 shall be applied.

An 'earth mat' is provided around high voltage locations as part of the earth protection arrangements for the high voltage installations. All cables (signalling and communications) to be installed within 20 metres of the earth mat shall be run in pipes

### 5.4.6.3 Spare buried pipes

Spare pipes shall be provided as shown in Table 1:

**Table 1 – Spare pipes**

| Cable route | Spare Pipes |
|---|---|
| Type 2 | One |
| Type 3 | Two or 20% of the number of pipes whichever is the greater(Note 1) |
| Type 4 | One or 20% of the number of pipes whichever is the greater(Note 1) |
| Type 4a | One |

Note 1: In determining the number of spare pipes to be provided based upon the percentage of pipes, reference shall be made only to the resultant whole number and fractions shall be ignored.

Where a Type 2 or 3 route is specified, the spare pipe(s) shall be laid over the cover strip as shown in Figure 6.

Where a Type 4 route is specified the spare pipes shall be laid over the other pipes as shown in Figure 7.

#### 5.4.6.4 Pipes in platforms and other paved areas

Pipes shall be arranged in fixed format for the full length of the platform or paved area and shall be supported so that backfilling will not disturb the format.

Where only pedestrian traffic is involved the depth of the pipes from the top of the trench to the top of the highest layer of pipes shall be not less than 300 mm.

Where motor vehicles can run over the surface the pipes shall be buried not less than 300 mm and a reinforced concrete slab, minimum 150mm thick and overlapping the pipes by 300mm each side shall be provided immediately under the pavement surface material.

Cable pits for cable pulling purposes shall be provided in platforms in accordance with the requirements of Section 5.10.

## 5.4.7. Buried cables through watercourses

- Where cable routes are required to cross watercourses, the following requirements apply:
- For small creeks and occasional waterways the cables shall be enclosed in pipes laid in trenches not less than one metre under the creek bed.
- The pipes in the creek bed shall be covered to a minimum depth of 300mm with porous bags filled with stabilised sand and the remainder of the trench then filled to the top with heavy grade hardcore.
- The pipes on creek banks shall be laid at a gentle slope in grooves in the banks so that the pipes have a minimum cover of 800 mm.
- The pipes on the creek banks shall be secured in position with suitable anchors and covered with porous bags filled with stabilised sand and topped with other suitable fill to protect the pipes and prevent erosion of the banks.
- Areas of erosion on creek banks shall be avoided. If this cannot be achieved, stabilisation of the bank on each side of the trench shall be provided.
- The buried pipes shall be extended past the edge of the creek banks a minimum of four metres on either side of the creek or waterway. The minimum depth of the whole of this pipe run shall be 800mm.

The requirements of JH-MAN-ENV-001 shall also apply.

### 5.4.8. Underground services of other parties

Where an existing buried service will be affected by the proposed cable route, the following requirements apply:

- the buried cable route shall be laid 500mm below the existing buried service or, if this is impractical,
- troughs or pipes shall be laid over the obstacle and continued for three (3) metres each side of the obstacle.

### 5.4.9. Cable route markers

Cable route markers shall be manufactured in accordance with the CRN standard drawing M05-049 CRN and shall be installed on all buried cable routes as follows:

- In yard areas the markers shall be mounted on posts with 500mm protrusion above ground (or on an adjacent fence line where available).
- In all other areas markers shall be mounted on posts with 1200mm protrusion above ground.

Cable route markers shall be installed:

- at each point where the route changes direction,
- at each end of under-track, under-road and under-creek crossings, and
- at not greater than 50 metre intervals along the route such that at least two markers shall be visible at any point along the route.

Cable route markers shall be placed

- close to a fence or other fixed structure and in such a position that they are not likely to be damaged by track maintenance or other vehicles.
- they shall not be placed directly over the cable route.
- In yard areas they shall not obstruct footpaths, walkways or vehicle access-ways.

## 5.5. Ground Level Troughing (GLT): Cable Route Type 5

GLT shall be installed in accordance with the requirements of CRN CS 540.

The following requirements apply:

- Ground level troughing (GLT) shall be manufactured from reinforced concrete in accordance with CRN standard drawings M07-100 and M07-101 or from type approved moulded HDPE, LLDPE (MDPE) or GRP (e.g. Vinidex "Railduct 2000").

- If GLT is to be used in an area where vehicle access is possible, the trough and lid shall be capable of carrying a load of 4.5 tonnes over a contact area of 100mm x 300mm applied to any part of the lid.
- Concrete troughing shall be fitted with lids as shown on CRN standard drawings M07-100 and M07-101 with 'CRN' embossed on the top of all lids in letters not less than 50 mm high and 5 mm deep.
- GLT shall be installed with the top of the lid at ground level in areas which vehicles can access and with the top of the lid up to 75mm above ground level where vehicles cannot access.
- Concrete troughing shall be accurately manufactured to enable each segment to interlock securely with each other and lids to fit securely on the top of the troughing without rocking.
- All cable entry points to GLT shall be sealed with an approved compound to prevent the entry of rodents and vermin.
- One or more troughs shall be installed to provide the necessary capacity to accommodate the cables and provide 30% spare capacity, in each compartment of the trough, to provide for future requirements.
- Communications cables shall not be installed in the same compartment within the GLT as power or signalling cable and high voltage cables shall not be installed in the same compartment as signalling cables. The requirements of HB 29 2007 shall apply.
- GLT runs shall have the least practical number of changes of direction and gradient.
- The method used for change in direction of GLT route shall be determined by the extent of the angular change in direction and the minimum bending radius of the largest cable in the route. The GLT may either be cut in a series of angles or a turning chamber may be used. Moulded or formed bends or similar shall be used with HDPE or LLDPE trough.
- Particular care shall be taken in the construction of a GLT route on embankments and sloping sites to ensure that the supporting ground will not be eroded during periods of rain.
- Where GLT is being installed near a running line it shall be positioned such that it will not obstruct or be likely to be damaged by, the removal and replacement of railway sleepers. GLT to be installed within three metres of the face of the nearest running rail shall be installed such that the top of the GLT lid is not higher than 200mm below the underside of adjacent sleepers.
- Track and other drainage within CRN's boundary shall not be affected by the installation of GLT. The design shall include ramps over drains, ducts and pipes under the GLT route.
- Where GLT could act as a barrier to slow the dispersal of water during wet periods, the design shall include installation of drainage ducts under the GLT at intervals to facilitate

appropriate drainage. These shall be located at vantage points to enable the quick dispersal of storm water.

- Drainage ducts may be constructed from inverted GLT, pre-cast concrete box drains or PVC or HDPE pipes etc.

## 5.6. Galvanised Steel Troughing (GST): Cable Route Type 6

### 5.6.1. Troughing material and construction

- GST shall be constructed from steel, hot dip galvanised to AS 1650 with a coating mass equal to Z430 or better.
- The trough shall conform to the minimum base metal thicknesses shown on CRN standard drawings M07-114 for the various size ranges but variations in shape (height and/ or width) are acceptable. Troughs with a side wall height of 140mm or more shall have a stiffening rib in each side wall similar to that shown on the drawing.
- The bottom and sides of the troughing shall be provided with a continuous 9mm thick lining of stable thermal insulating material such as fibre-reinforced cement for fire protection.
- Troughing support brackets, fixings and other fittings shall be of sufficient strength to support the troughing without permanent deflection when loaded to full capacity with cable plus incidental loads up to 100kg applied at any point on the trough. A safety factor of not less than three (3) shall be applied to the brackets.
- All components shall be protected against corrosion or made of corrosion resistant materials, which will provide a service life of at least 30 years.
- Steel troughing shall be generally constructed using six metre long lengths of troughing. Shorter length troughing may only be used to accommodate changes in direction of the route, or to suit equipment positions.
- Cable jointing bays shall be provided as required to ensure that there is no net reduction in trough capacity where cable joints occur and the bays shall be supported to prevent any deflection or twist of the jointing bay or cable route.
- Steel troughing on walls or in tunnels shall not obstruct access to staff refuge recesses.
- In restricted areas, and only where clearance limitations demand it, such as in tunnels and along platform walls, slim-line cable ladders may be used in lieu of the steel troughing in accordance with the provisions of Section 0.
- One or more troughs shall be installed to provide the necessary capacity to accommodate all the main and local signalling, and low voltage power cables in the cable route plus an allowance of not less than 30% spare capacity to provide for future requirements.
- Additional and separate troughs shall be provided for :-

- High voltage power cables
- Communications cable

- The minimum radius of all bends in the steel troughing route shall comply with the requirements of Section 5.1.1**.** All bends shall be smooth and rounded to prevent damage to or pressure on cables due to sharp corners or edges.

  Changes in direction in the vertical or horizontal plane of the troughing route shall be at a maximum angle of 22.5° in all cases. Where, for example, 90° bends are required, they shall be made up of four 22.5° bends.

- Troughing expansion joints shall be installed in the troughing runs at intervals of not greater than 50 metres and each expansion joint shall provide for change in length for a temperature range -5° to 60° C.
- The troughing shall be fixed to the troughing support brackets at the expansion joint only and arranged so that the troughing between expansion joints is free to expand and contract with temperature changes.
- To minimise the effects of induced currents in steel troughing, insulated saddle joints shall be installed in steel troughing runs at intervals of not greater than 300 metres and at each end of steel bridges when the route is attached to or supported by the bridge.
- The insulated joints shall be arranged to provide a gap of 30mm between the ends of adjacent lengths of steel troughing.
- Troughing brackets shall generally not extend past the side of the trough by more than 25mm.
- Steel troughing shall be fitted with lids. The lids shall be secured with stainless steel strapping, one 100mm from each end of each lid plus additional straps as required to ensure a maximum of two (2) metre intervals between straps.

## 5.6.2. Troughing support

### 5.6.2.1 Troughing on posts

- Free standing GST shall be mounted on posts set in the ground to a depth of at least one third of the total length of each post or 500 mm, whichever is the greater. All posts shall be vertical.
- Posts shall be spaced so that any trough attached to the posts will not deflect or distort when loaded as specified in Section 5.6.1 with the incidental load at the mid-point of the span. Post spacing shall be consistent except where a reduction is necessary for change of direction, support of a joint bay or termination of route. Post spacing shall not exceed 2 metres unless otherwise approved in the design.

- Posts shall be of sufficient section to support and shall not move in the ground with a vertically applied load of 250 kg and/or with a load of 150 kg applied horizontally to the top of the post in any direction.
- The minimum height from ground level to the bottom of the lowest trough on a post line shall be 500mm.
- The maximum height from ground level to the top trough on a post line shall be determined on the site survey.

#### 5.6.2.2 Troughing on structures

A GST cable route may be attached to the structures of bridges and viaducts, rock faces, retaining walls and through tunnels where designed and approved in accordance with the requirements of CRN CS 310, CRN CS 320 and CRN CS 330 and the following requirements:

**On rock faces**

- The GST shall be supported by brackets epoxy grouted into holes bored in the rock face.
- Bracket lengths shall be varied as necessary to account for variation in the line of the rock face
- The bracket shall be suitably braced where projection of more than 400mm from the rock face is required.
- The brackets and braces shall be of sufficient strength, and the depth of penetration into the rock face shall be sufficient, to support the loadings and safety factor specified in Section 5.6.1.
- Spacing shall comply with the requirements of Section 5.6.1.
- The minimum height to the bottom of the lowest trough from ground level shall be 500mm.
- Troughing attached to rock faces shall have a minimum clearance between the trough and the rock face of 25mm.

**On retaining and other walls**

- Secure fixings must be obtainable.
- Attachment to the wall shall be by stainless steel chemical masonry anchors of not less than 12mm in diameter with a minimum anchoring depth of 75mm.
- The brackets shall be of sufficient strength to support the loadings and safety factor specified in Section 5.6.1.
- Spacing shall comply with the requirements of Section 5.6.1.
- The minimum clearance between the troughing and wall shall be 25mm.

**In tunnels or through underbridges with limited clearances**

- GST may be mounted in tunnels and through underbridges where clearances are limited at low level or where the troughing would interfere with access to refuges, at a height not less than 3800mm above rail level

**On purpose designed structures**

Where it is not practical or desirable to install a cable route under culverts, gullies, stormwater channels, etc. or to use above ground troughing on posts, a bridge structure may be designed and installed to support the troughing.

The bridge structure shall be:

- wide enough to carry the number of troughs required
- of sufficient strength to avoid permanent deflection under the weight of the all troughs plus 100% cable load in each trough plus two incidental loads of 150 kg, one at 1/3 span and one at 2/3 span. A safety factor of at least three (3) shall be applied.
- supported on bearing plates, fixed at one end and free to expand/contract at the other.

Matched expansion joints shall be provided in each trough.

## 5.6.3. Transitions

Where a transition is required between GST and GLT it shall be made in accordance with the arrangement shown in Figure 10.

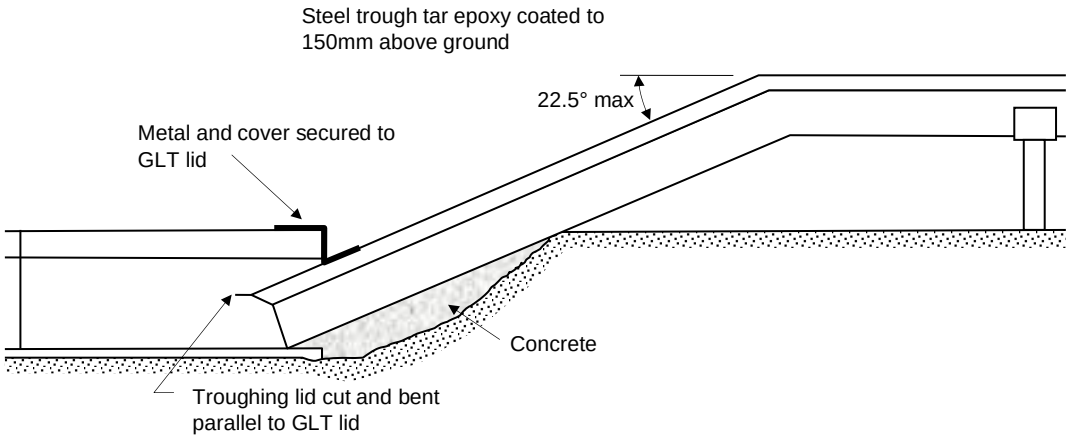



**Figure 10: GST /GLT Interface**

Similarly, where a transition is required between GST and buried route it shall be made in accordance with the arrangement in Figure 11.

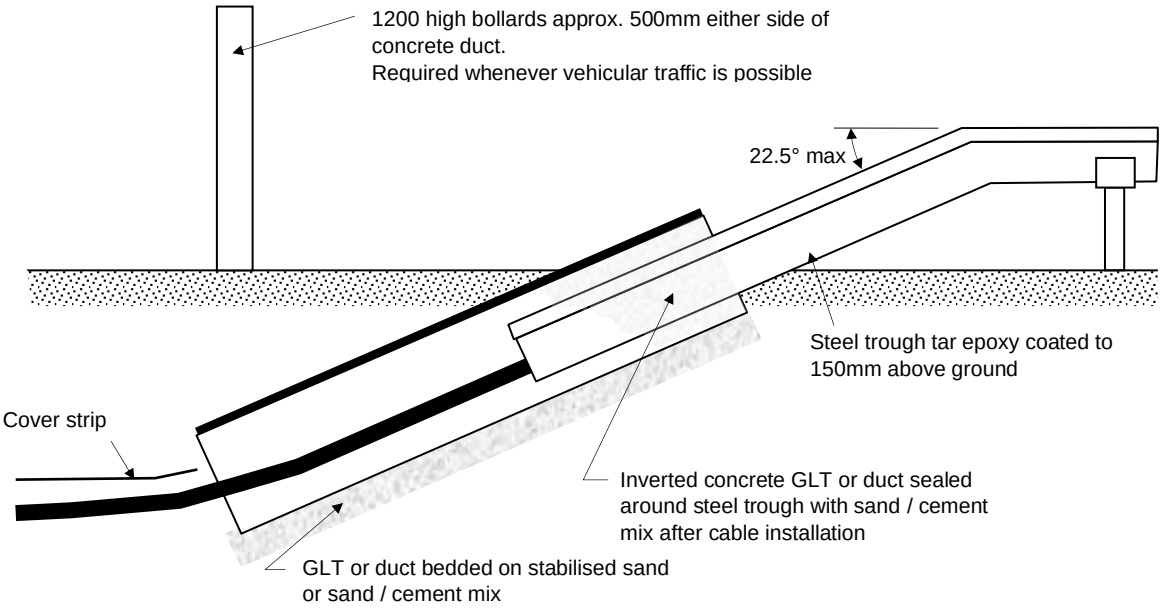



**Figure 11: GST / Buried cable interface**

The transition between GST and ULX and URX's shall meet the following requirements:

- It shall be made with a purpose built adaptor manufactured to the same material standards applying to galvanised steel troughing.
- The adaptor shall be large enough to accommodate all pipes, including spares, from the buried cable route, ULX or URX,
- The adaptor shall extend from the cable route to within 300mm of ground level.
- The void between the adaptor and the pipes shall be sealed.
- Modifications to the GST route to accommodate the adaptor shall not result in cables being unsupported over lengths exceeding 600mm.

Where GST enters a pit the transition shall be made in accordance with the arrangement shown in Figure 12.

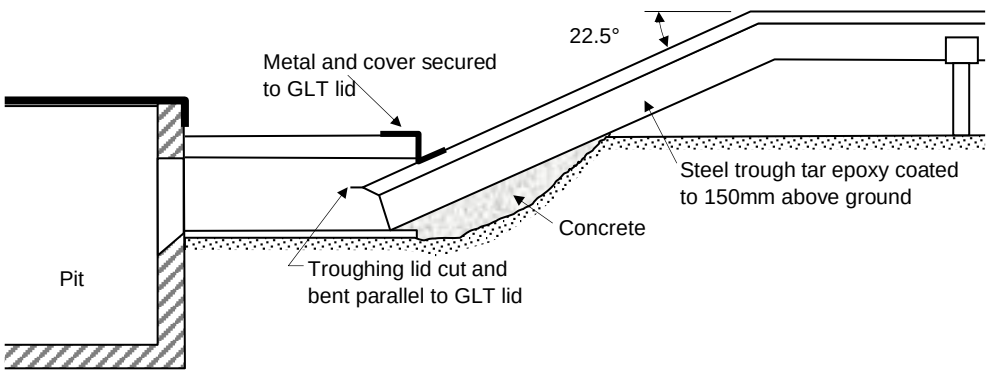



**Figure 12: GST to pit interface**

Where steel troughing enters a location case the transition shall be made in accordance with the arrangement shown in Figure 13 which illustrates the arrangement for typical site conditions.

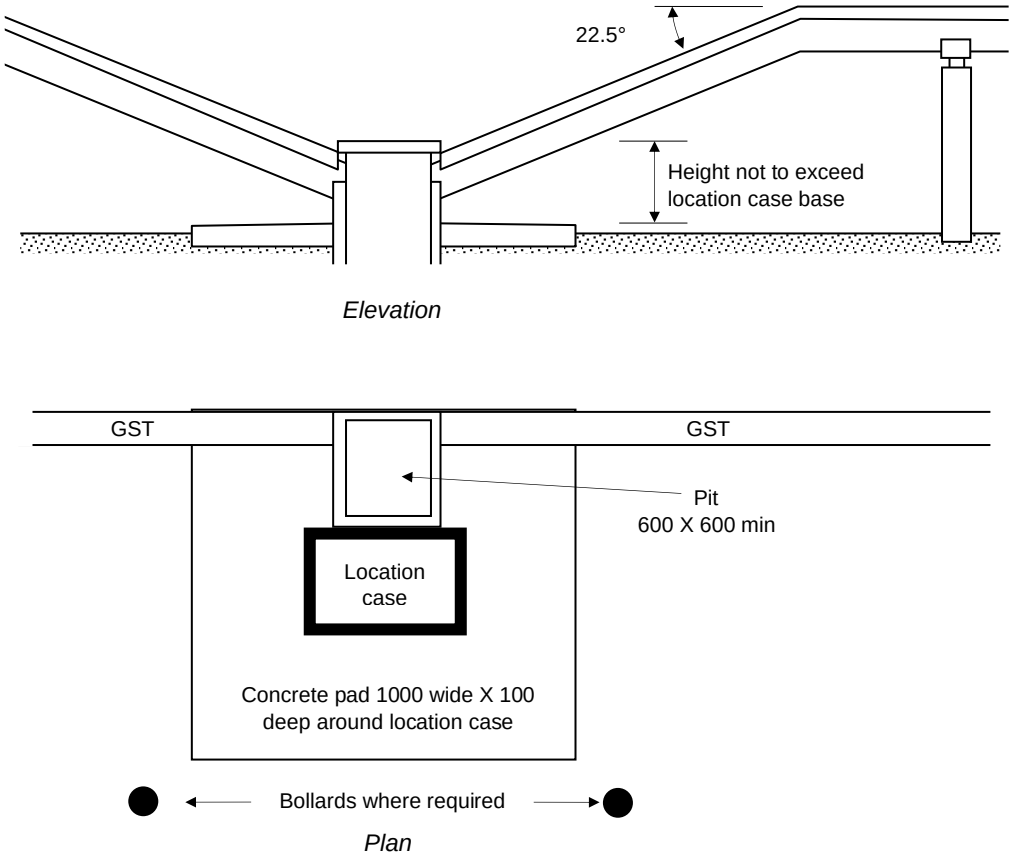



**Figure 13: GST to location case**

# 5.7. Cable Ladder: Cable Route Types 7, 8 and 9

## 5.7.1. Ladder material and construction

- Cable ladder shall be manufactured from marine grade aluminium or stainless steel or, in areas that are not subject to ground water leaching through the tunnel or platform wall, galvanised steel.
- Ladder widths shall be 150mm, 300mm, 450mm or 600mm. Other widths may be used if space limitations dictate.
- The ladder shall be of adequate strength to support the cable route when full to capacity with cable plus an additional load of 10%, or 10kg whichever is greater, without permanent deflection.
- Cable ladder cable route shall be generally constructed using the maximum available lengths of cable ladder. Shorter lengths of cable ladder shall only be used to accommodate changes in direction of the route, or to suit equipment positions.

- Cable ladder cable route shall be constructed and the ladder supported in accordance with the manufacturer's specifications or recommendations.
- Sufficient cable ladders shall be installed to provide the necessary capacity to accommodate all the main and local signalling cables, and low voltage power cables in the cable route plus an allowance of not less than 30% spare capacity to provide for future requirements.
- Separation of cables shall be as required by HB 29 2007.
- The minimum radius of all bends in the ladder route shall comply with the requirements of Section 5.1.1.
- All bends shall be smooth and rounded to prevent damage to or pressure on cables due to sharp corners or edges.
- Changes in direction in the horizontal and vertical planes of the ladder route shall be constructed using the appropriate pre-formed bends and tees from the ladder manufacturer's range.
- Joints in the cable ladder shall use the appropriate splice plate from the ladder manufacturer's range and be fixed using the recommended size of fastener. Fastener material shall not corrode or cause corrosion of the ladder in the environment in which the ladder is installed.
- Expansion joints shall be installed in the ladder route at intervals of not greater than 100 metres using appropriate splice plates and purpose designed fasteners. Attachment to brackets between expansion joints shall be purpose designed to permit movement of the ladder due to change in temperature
- Insulation air gaps of 30 - 40mm shall be installed in the cable ladder route at intervals of not more than 300 metres.
- Cables shall be attached to the cable ladder using stainless steel cable ties at intervals not exceeding 600mm.
- Cable ladder covers are only required where the bottom of the cable ladder is less than 2.4m above the adjacent rail level unless otherwise specified in the design.
- Cable ladder covers shall overlap the adjacent covers by a minimum of 20mm (away from the direction of normal train movements) and shall be secured with stainless steel straps, one 100mm from each end of each lid plus additional straps as required to ensure a maximum of 600mm intervals between straps for 600mm wide ladder and a maximum of 800mm intervals between straps for other ladder widths.

## 5.7.2. Ladder support

- Cable ladder brackets, supports and fittings shall be strong enough to support the loading specified in Section 5.7.1 without deflection or distortion of bracket or support.
- Ladder supports shall be secured to tunnel walls or structures in accordance with a design that meets the requirements of CRN CS 310, CRN CS 320 and CRN CS 330;
- Cable ladder brackets and supports shall be constructed of materials that are compatible with the ladder material and will not result in electrolytic corrosion under the installed environment.
- All bolts shall include self-locking nuts or other nut locking methods.
- Where cable ladders are installed through tunnels or through underbridges:
    - ladder and ladder supports and brackets shall be installed clear of water springs, seepage and weep holes.
    - Support centres shall not exceed two metres.
    - A minimum clearance of 25mm shall be maintained between the cable ladder and the walls of the tunnel or underbridge members.
    - the main cable ladder shall be mounted such that the lowest part of the ladder is at least 3800mm above rail level.
    - the ladder shall not obstruct access to refuges under any circumstances.
    - ladders on an irregular or rough finished tunnel wall (such as a shotcrete finished wall) shall be maintained in generally straight alignment by using stand-off pillars as necessary.

## 5.7.3. Transitions

- The transition between different cable ladder sizes shall be made using purpose built adaptors from the ladder manufacturer's product range
- The transition between cable ladder and GST, GLT, pits or buried route including ULX and URX shall be made using purpose built adaptors fabricated from the same material as the cable ladder.
- The adaptor for ULX and URX shall be large enough to accommodate all pipes from the ULX or URX, including spare pipes and shall extend from the cable route to within 300mm of ground level.
- The void between the adaptor and the pipes shall be sealed.
- Modifications to the cable ladder to accommodate the adaptor shall not result in cables in the cable ladder being unsupported over lengths exceeding 600mm.

- The connection of the main cable ladder route to local cable route and equipment shall be made using purpose built tee pieces from the ladder manufacturer's product range.

## 5.8. Steel pipe cable route

Where approved for use, the pipe shall be a 50mm minimum diameter nominal bore medium galvanised steel pipe (AS 1074). The pipe shall be attached to a platform coping wall or tunnel wall using stainless steel full saddles at centres not exceeding 1500mm. Saddle connections shall also be installed adjacent to each side of any change in direction of the pipe and adjacent to any connection to equipment.

Saddles, other than those at changes in direction, shall allow for pipe expansion and contraction. Where necessary, an expansion sleeve shall be provided in the pipe.

The saddles shall be attached to the walls in accordance with the requirements detailed in CRN CS 330.

## 5.9. Underline (undertrack) and under-road crossings (ULX and URX)

All ULX and URX installations shall conform to the requirements of CRN CS 540 and the following additional requirements:

- All ULX and URX shall include a minimum of 25% spare capacity with an absolute minimum of 3 spare pipes in main route ULX and URX and one spare pipe in local route ULX and URX.
- No spare pipes are required for individual track circuit feeds or tail cables to individual pieces of equipment.
- Where a single large diameter pipe is installed by boring, spare capacity in this pipe, provided it is not less than 50% of the cross sectional area, may be accepted in place of additional pipes.
- The spare capacity in large pipes shall be sealed at each end of the pipe following the cable installation.
- ULX pipes shall extend not less than four (4) metres beyond the outer rail on each side of the track except where the CRN rail corridor ends within 4 metres or there is a physical obstruction that precludes this requirement.
- A cable pit (in accordance with the provisions of Section 5.10) shall be provided at each end of main cable route ULX pipes.
- URX pipes shall extend under nature strips and pathways into CRN property on each side of the roadway sufficiently to provide a cable pit at each end of the URX that is wholly

within CRN property. Where the URX is wholly within CRN property, the cable pits shall be at least 2.4 metres clear of the roadway edge.

- Where CRN property is unfenced or where the URX is wholly within CRN property, bollards shall be installed on the road side of the pits to protect them from vehicular traffic.

## 5.10. Cable pits, cable jointing pits and cable turning chambers

### 5.10.1. Cable sharing in pits

Communication cables shall not occupy pits with signalling or power cables unless the separations specified in Section 5.4.2 are maintained by fixed cable trough, ladder, tray or conduit within the pit.

Installation of high voltage power cables in pits with low voltage and signalling cables should be avoided. Where necessary to locate in the same pit, the high voltage cable(s) shall be grouped and covered or wrapped with the covering or wrapping being generally orange in colour with labelling giving the voltage(s) that the cables are carrying.

No other cables shall be placed in high voltage jointing pits.

### 5.10.2. Location of pits

Pits shall not be located within three (3) metres of the nearest rail of any track.

Where the width of the CRN rail corridor prevents this, pits shall be placed as close to the corridor boundary as possible.

The location of all cable pits cable jointing pits and cable turning chambers shall be as documented in the design.

Cable pits shall be provided:

- at each end of main cable route ULX and URX,
- where Type 3 or Type 4 cable route is specified placed at intervals of not greater than 250 metres.
- where Type 4a cable route is specified placed at intervals that allow drawing in of cables such that it is physically possible by mechanical means and that no damage results to the cable itself by the drawing in process
- at interfaces of Type 3 or Type 4 routes with other type cable routes
- where Type 3 or Type 4 routes change direction.
- at entries to equipment buildings.

Cable jointing pits shall be provided wherever:

- Optic fibre cable is to be jointed and a suitable communications cable termination cabinet does not exist.
- High voltage cable is to be jointed.
- where road access is available for the splicing of optical fibre cables.

Cable turning chambers shall be installed in GLT, GST and cable ladder routes wherever cables are required to change direction sharply and either:

- The minimum bend radius for the cable cannot be achieved within the GLT, GST or cable ladder or,
- The cable is likely to bear heavily against sharp edges at the bend.

## 5.10.3. Pit design

Cable pits, cable jointing pits and cable turning chambers shall be constructed in accordance with the following requirements as specified in the design.

**Pit construction**

- Cable pits and cable turning chambers may be made from precast concrete, concrete cast in situ, brick, concrete block, glass reinforced cement (GRC), High Density Polyethylene (HDPE), glass reinforced polymer (GRP) or polyester cement depending on size, location and the loading to which the pit cover will be subject.
- Concrete, concrete block and brick pits and cable turning chambers shall have a concrete floor of not less than 75mm thick.
- GRP, GRC and polyester cement pits and cable turning chambers shall be bedded on stabilised sand or roadbase not less than 75mm thick.
- Cast in situ concrete pits and cable turning chambers less than or equal to 1500mm deep shall be constructed with a minimum wall thickness of 100mm with a layer of F82 galvanised mesh reinforcement. The reinforcement shall be located to provide a minimum cover of 50mm from the outside of the wall.
- Cast in situ concrete pits and cable turning chambers deeper than 1500mm shall be constructed with a minimum wall thickness of 150mm with two layers of F62 galvanised mesh reinforcement. The reinforcement shall have a cover of 50mm.
- Pits and cable turning chambers constructed from brick or concrete block shall include appropriate steel reinforcement.

**Depth**

- The depth of pits and cable turning chambers shall suit the depth of buried cables or pipes, as applicable.

- The top of each pit or cable turning chamber shall be 100-200mm above the surrounding ground level except on platforms, paved areas, pathways or roadways, sealed or unsealed, where the top of lids shall be flush with the surrounding ground level and the pit and lid shall be load rated to the vehicular or pedestrian load applying to the location.

**Dimensions**

- The internal size of all pits and cable turning chambers shall provide for the minimum bending radius of the largest cable to be installed in them
- Any pit more than 600mm deep shall be large enough to provide for a person to stand in the pit clear of cables.
- The minimum internal diameter of round pits in main cable route shall be 1000mm to a depth of 1500mm, 1200mm if over 1500mm.
- The minimum internal size of square or rectangular pits in main cable route shall be 600 x 600mm to a depth of 1500mm, 1000 x 1000mm if over 1500mm.
- Pits associated with GST to location case interface shall have minimum dimensions of 600mm x 600mm as shown in Figure 13.

**Pipe entry**

- All cable entries into pits and cable turning chambers shall have large radius rounded edges to prevent damage to cables during installation and to eliminate the danger of cables bearing on sharp corners or edges after installation.
- The ends of pipes and conduits shall be de-burred and chamfered.
- Where pipes or GLT enter pits or cable turning chambers the pipe ends or GLT shall be encased in concrete for a distance of not less than 300 mm to hold them securely in position.

**Cable support**

- An approved bracket or tray shall be built into the side of each cable jointing pit for securing the optical fibre cable joint unit. This shall be 200mm from the top of the pit on the opposite side to the cable route.
- To provide for the support of cables in the vertical plane purpose made brackets and fittings shall be supplied and installed, at intervals of not greater than 600mm. Alternatively cable trays or ladders may be used.

**Access**

- Pits and cable turning chambers in excess of 750mm deep shall have rungs (minimum width 300mm constructed from 20mm diameter galvanised steel rod or other approved material) cast into the wall at 300mm (maximum) centres, to permit safe and easy entry and exit from the pit or chamber.

- Alternatively, a galvanised steel ladder (of suitable length, with minimum width of 300mm and 20mm diameter rungs) fixed securely to the wall at the top and the bottom of the ladder, may be provided.

**Pit drainage**

- Where pits and cable turning chambers are installed on embankments, they shall comply with the requirements documented in CRN CS 410.
- Drainage arrangements shall be provided at the base of each pit and cable turning chamber. These shall include installing drainage pipes to the nearest approved railway drain or to a public stormwater drain or natural drainage course, where possible.

**Covers**

- All cable pits and cable turning chambers shall be provided with removable covers.
- In platforms, other paved areas, sealed or unsealed roads and pathways 'Gatic' covers (or an approved equivalent) shall be used and shall be rated for the vehicular or pedestrian load applicable to the location.
- Covers on all other pits and cable turning chambers shall be capable of carrying incidental live loads of 1.5Kpa and shall be sectioned as necessary to limit the maximum weight of each section to 45kg.
- Gatic or similar covers shall be provided with recessed sockets or eyes for lifting with appropriate tools. All other covers shall be provided with recessed or retractable handles so that the cover can be removed without tools.
- Except for covers in platforms, paved areas, sealed or unsealed roadways and pathways, covers shall be secured to pits and cable turning chambers with padlocks or similar to guard against theft and vandalism.

# 5.11. Signalling equipment

## 5.11.1. Signal and gantry foundations

### 5.11.1.1 Location of signal and gantry foundations

The foundations for signals and signal gantries shall be installed at the position, and at the distance from rail and height above rail, indicated in the design.

### 5.11.1.2 Signal foundation design

The design and placement of all signal foundation installations shall comply with the requirements laid down in CRN CS 330.

The following additional requirements apply:

- The foundations for post mounted signals shall be of sufficient size, shape and depth in ground to support fully dressed signals in wind speeds to 160 km/h for areas south of a line through Taree and 180km/h north of that line, without the need to rely on staying, bracing or the ladder for support.
- The foundation shall also be capable of supporting the signal plus two (2) maintenance staff on the signal ladder or platforms in wind speeds up to 80kph.
- Ground mounted shunt signal foundations shall be of sufficient size, shape and depth in ground to support the signal and any route indicators attached thereto subject to the minimum depth in ground being 600mm and the minimum cross section being 350mm diameter.
- The foundations may be pre-cast concrete or cast in situ.
- Bolts of the size specified in CRN SC 015 shall be cast into signal foundations to enable the signal posts or ground mounted signals to be bolted on and removed without disturbing the foundations.
- The signal post holding-down bolts shall be installed vertically in the foundation castings and the top surface of foundations shall be completely level.
- Cable entry conduits of not less than 50mm diameter shall be cast into signal foundations.
- The portion of signal foundations visible above ground shall be neatly finished with smooth surfaces free of voids and shall have chamfered edges.
- Square foundations shall be parallel to the track.
- In areas of solid rock, and where approved in the design, the signal post holding-down bolts may be grouted directly into the rock.

#### 5.11.1.3 Gantry foundation design

The design and placement of all signal gantry foundation installations shall comply with the requirements documented CRN CS 330.

The following additional requirements apply:

- Gantry foundations shall be of such a size and depth to adequately support the gantry, signal cages, signals, walkway and handrail, incidental loadings from maintenance personnel, overhead wiring loads (where applicable) and resist wind loadings, in the terrain category applicable to the location, for wind velocities up to 160 km/h.

#### 5.11.1.4 Access

Telephones may be installed at signals and signal gantries for drivers use in case of emergency or during delays or interruptions to railway traffic. Where such installations are documented in the design:

- Safe and easy access shall be provided to all such telephones and, if necessary a walkway from the track to the signal telephone shall be formed for drivers' access.
- Handrails shall be provided, where necessary, to protect train drivers from drains or embankments, etc.

## 5.11.2. Location cases

### 5.11.2.1 General

Location case foundations and platforms shall be designed to meet the requirements documented in CRN CS 330.

Note: "Foundation" includes both the concrete area under and the concrete surrounding the location case.

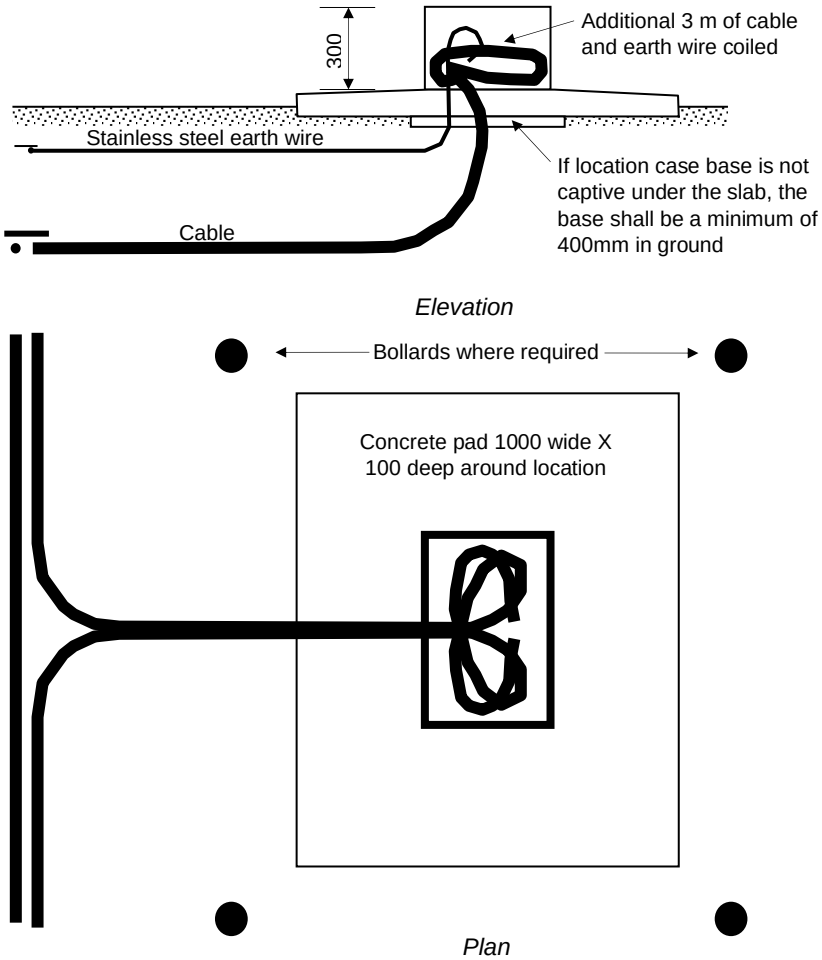
"Platform" includes the metal platform, the associated supporting steelwork, handrails and ladders/steps, for locations on sloping sites or where the location case is to be elevated to avoid local flooding.

The following additional requirements apply:

### 5.11.2.2 Location case foundations and associated work

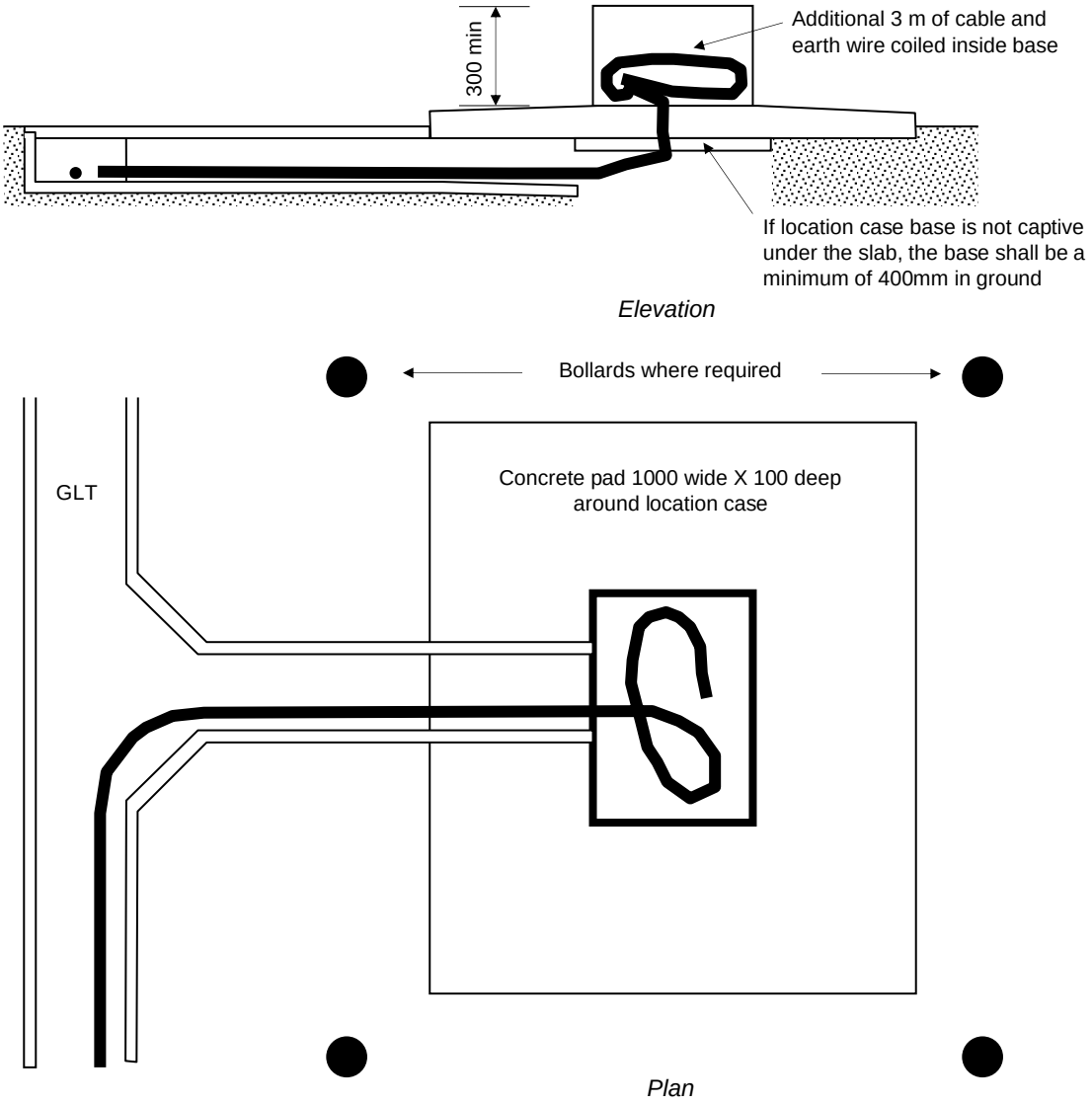
**Layout**

Figure 13, Figure 14 and Figure 15 illustrate acceptable arrangements for the layout of a location case foundation on level, stable ground with the cable entries from steel troughing on posts, a buried cable route and ground level troughing respectively.




As shown for level ground. Footings, retaining walls, access paths, steps/ladders as required.

**Figure 14: Buried route to location case**




As shown for level ground. Footings, retaining walls, access paths, steps/ladders as required.

**Figure 15: GLT to location case**

**Site design**

- For sloping or unstable sites a specific foundation design shall be documented, but the layout and method of cable entry shall, as far as possible, be similar to those indicated in Figure 13, Figure 14 and Figure 15.
- Concrete or brick retaining walls shall be provided where necessary to form a secure level area for location case foundations.
- The design of location case foundations and location case platform foundations shall not impede drainage or lead to scouring or erosion.
- The base of location cases shall be not less than 300mm above the concrete area surrounding the location cases.

- In low lying areas, the top of the location case base shall be at a height not lower than the recorded or projected 100 year flood level for the area.

### 5.11.2.3 Location cases on raised metal platforms

Where it is not practical to install concrete foundations for location cases such as on steeply sloping sites and over culverts, etc. raised metal platforms shall be designed and installed.

The design of the platforms shall comply with the relevant parts of AS1657. In addition:

- each platform shall be capable of carrying a minimum of six (6) persons in addition to the location case(s) and shall not bend, distort or sway or vibrate under this load and any combination of this load and wind loading (from passing trains).
- Metal supporting posts shall be securely anchored in concrete foundations. Where the ground is sandy or uncompacted, foundations shall be strip footings rather than individual footings under each post.
- The area under and extending up to 1000mm beyond the extremities of the raised platforms shall be covered with 50mm of concrete.
- The area under the raised platform shall be enclosed to prevent the build-up of rubbish and the growth of grass or scrub underneath that could put location case contents and associated cables at risk in the event of fires, etc.

### 5.11.2.4 Steps, ladders and handrails

- Where location cases are installed above ground level, fixed steps or ladders shall be provided where necessary to provide easy and safe access for maintenance and construction staff.
- Handrails meeting the requirements of AS 1657 shall be provided on all steps and around the foundations of all location cases that are located on embankments, etc. or where the safety of maintenance or construction staff could be at risk from accidentally stepping off an above ground structure.
- Handrails shall also be required at ground level location cases where staff could step back into a track drain, culverts, etc. and on the track side of the location case where the location case is within 3600mm of the nearest rail of any track.
- Stairs and Ladders to location cases shall comply with the requirements of AS 1657 in respect to selection of step type ladders or rung type ladders, stile, tread and rung sizes and the provision of safety cages and intermediate platforms.
- Steps shall be not less than 600mm wide and ladders shall be 450mm wide.

#### 5.11.2.5 Cable entries to location cases

Cable entries to all concrete location case foundations shall comply with the requirements set out in Section 5.11.2.2.

Cable entries to location cases on raised platforms shall be designed for each location and shall meet the following requirements:

- The cables between ground level and the platform shall be encased in 100mm diameter PVC or HDPE pipes or in steel troughing or in enclosed cable tray.
- Pipes, trough or tray shall be securely fixed at ground and platform level.
- Cables in the vertical plane shall be secured at intervals of not greater than 600 mm to prevent the cables from sagging and causing undue pressure on cables at bends or on cable terminations in the location cases.

#### 5.11.2.6 Access to location cases

Access shall be available to all location cases as follows:

- From the track in the immediate vicinity unless otherwise indicated in the design.
- From an adjacent public road where available alongside the railway line and location cases are positioned inside the boundary.
- A personnel access gate in the boundary fence shall be provided in accordance with the requirements of Section 5.12.3.
- Paths and safety handrails shall, where necessary, be provided between the access gates and location cases.
- Where pre-existing gates are to be used for access to the location cases, the paths, steps and handrails shall be upgraded to comply with this standard and/or the relevant CRN Civil and/or Australian Standards.

### 5.11.3. Communications cable termination cabinet foundations

#### 5.11.3.1 General

Communications cable termination cabinets shall be provided in the cable route at railway stations and other locations where documented in the design.

Communications cable termination cabinets are generally Krone or Rittal type cabinets unless otherwise approved.

#### 5.11.3.2 Foundations for cable termination cabinets

Foundations for communications cable termination cabinets shall be designed in accordance with the requirements documented CRN CS 330 and CRN CS 540.

The following additional requirements apply:

- The cable termination cabinet foundation shall consist of a concrete slab of sufficient size to adequately support the cabinet based on local ground conditions. 100mm diameter pipes or a ground level trough (GLT) shall be set into concrete to provide access for the cables into the cabinet.
- The cable termination cabinet shall be supported on the concrete base by:
    - a raised concrete base 450mm high, or
    - a steel frame 450mm high shall be provided on the concrete slab to support the cable termination cabinet. The steel-framed plinth shall be enclosed in steel sheeting of not less than 2mm thick.
- On sloping or uneven sites retaining walls as necessary to support the foundations shall be provided. Safety rails shall also be provided where necessary to prevent staff from accidentally stepping off foundation platforms into drains or gullies or down embankments.
- Where it is necessary to install communications cable termination cabinets on embankments or over culverts, etc. the provisions of CRN CS 540 and CRN CS 410 shall apply.
- Access shall be provided to all communications cable termination cabinets similar to that provided for location cases as set out in Section 5.11.2.6.

## 5.11.4. Track circuit equipment

### 5.11.4.1 General

The design and installation of cabling and supports for track circuit equipment shall comply with the requirements documented in CRN CS 540.

Track circuit cables will generally be laid in with the main cable route for at least part of the way.

The following additional requirements apply:

### 5.11.4.2 Bootleg risers

- The most common applications of bootleg risers are AC, DC, AFO and Predictor track circuits and axle counter detection points / heads.
- The incoming cable from relay room or location case to the bootleg riser shall pass through the base and inside the pipe into the termination box. Four (4) RSA or similar terminals with links shall be provided within the box.
- Except where site conditions preclude, bootleg risers shall be installed:
    - 2500 mm (minimum) from the nearest rail face, and

- the top of the terminal box shall be 300 - 400 mm above ground level.

- Where track centres do not permit this position, the riser shall be placed:
  - centrally between tracks, and
  - the top of the box shall be at least 50mm below rail level.

#### 5.11.4.3 High voltage impulse and audio frequency track circuits

- Where the high voltage impulse and audio frequency track circuit trackside equipment can be installed within three (3) metres of the rail, surface mounted track connecting cables may be run directly to the trackside equipment.
- The posts and trackside equipment shall be installed opposite the applicable IRJ or track connection position to avoid excessive length on the track connecting cables.
- Posts used for mounting high voltage impulse and audio frequency track circuit trackside equipment and boxes shall be of sufficient cross section to support the box plus a load of 150kg applied horizontally at the top of the post (nominally 1 metre above ground level) with less than 20mm deflection. In addition the post shall have sufficient torsional rigidity to deflect less than 5° under a torque of 300Nm applied at the top.
- The posts shall be secured into the ground so that there will be no movement of the base of the post with a load of the box plus 150kg applied vertically to the post plus the load of 150kg applied horizontally at the top of the post or with these loads applied individually. The post shall also withstand a pullout load of at least 250kg.
- Incoming cable from location case to box shall be protected by either passing through the post or by a rigid conduit securely fixed to the post. Cables to the track shall be supported by clamping to the post to minimise loading on the cable terminations.
- Design life of the posts, the method of securing in ground, and conduits and cable supports shall be a minimum of 25 years.

## 5.11.5. Miscellaneous trackside equipment

### 5.11.5.1 Releasing switches

Where nominated in the design, releasing switch mounting posts shall be installed as follows:

- The releasing switch and associated telephone shall be mounted on a suitable post, equivalent to a 100 NB pipe, bolted to a concrete foundation similar to that used for a dwarf signal.
- The telephone shall normally be mounted behind the releasing switch at approximately 1250 - 1400mm above ground level.

- The releasing switch (that part which contains the handle and pushbutton) should be 1400 - 1500 mm above ground level.

### 5.11.5.2 Ground frame bases

Where nominated in the design, ground frame bases shall be installed as follows:

- Ground Frame bases shall consist of a concrete slab of not less than 150mm thick with suitable bolts cast into the slab for securing the ground frame in position.
- The bolts shall be of sufficient length to permit 25mm of timber packing or other suitable resilient material between the ground frame and the concrete.
- The operating platform for the ground frame shall consist of either a pre-cast concrete channel section or a steel fabrication with Gridmesh or similar decking.
- The minimum width of the platform shall be 600mm or the width of the ground frame plus 200mm whichever is greater.
- The minimum length of the platform shall be 1200mm.
- A step shall be provided at the end or one side of the platform.
- Cable arrangements to point detectors of ground frame operated points shall be similar to that required for electric switch machines.

### 5.11.5.3 Points equipment

Cable route and cabling to the points to provide for point controls and detection circuits shall be provided where nominated in the design.

The following requirements apply:

- From **buried cable routes** the cables to the points equipment shall remain buried then be brought up to the ground surface in 100mm diameter pipe positioned 2500mm from the rail face, adjacent to the points machine cable entry end. The cables shall then be run in flexible heavy duty orange PVC conduit or a superior approved conduit type to the point machine.
- From **ground level troughing (GLT)**, which is within the track formation, the cable from the GLT to the point machine shall be run in surface mounted flexible, heavy duty, orange PVC conduits or a superior approved conduit type.
- Where the **GLT** is not in the track formation or is on the other side of an access road to the points machine, the cables shall be buried 800mm deep between the GLT and 2500mm from the rail face and treated as for buried cable. 100mm pipe shall also be provided where the cable descends from the GLT into the ground.
- Similar requirements shall apply to steel troughing (GST) routes.

### 5.11.5.4 General purpose cases

General purpose cases include Emergency Switch Machine Lock (ESML) / Emergency Operation Lock (EOL) boxes

Where nominated in the design, ESML and/or EOL boxes and mounting posts complete with cable entries for the ESML and/or EOL shall be provided together with the cable route and cabling from the location case or relay room as applicable.

### 5.11.5.5 Buffer stop lights

The following requirements apply:

- Cables to buffer stop light posts shall be buried.
- The buffer stop light mounting post shall be capable of supporting a 150kg horizontal load applied at 1.5m above ground level with deflection of less than 10mm.
- The post shall be secured, into the ground or otherwise, so that it is capable of resisting a pull out force or 250kg plus the above specified horizontal loading without movement.
- The cables to the buffer stop lights shall be run in heavy duty rigid pipes, or within the post, from the ground to the lamp case position(s).
- Where metal buffer stops are provided, any metal work for the buffer stop light shall be insulated from the buffer stop frame itself or separately mounted and insulated, to avoid any touch potentials from the buffer stop.

### 5.11.5.6 Guard’s indicators

The following requirements apply:

- Guard's indicator mounting posts may be steel pipe (Minimum75NB) with capped top or RHS (minimum 75x75x3.2) whichever best matches the particular station architecture. (Note: On some stations, which are heritage listed, posts that more closely match the period architecture of the station may be required. Where these requirements apply they shall be nominated in the design.
- The post may be bolted to a concrete foundation or cast into a concrete foundation. The size of foundation shall be such that it can withstand a person swinging on the post without moving the foundation in the platform.
- The guard's indicator lampcase shall be mounted between 2200mm and 2400mm above platform level unless otherwise indicated in the design.
- The post shall be painted the same colour as the station lighting posts.
- Cabling to guard’s indicators shall be run in pipes buried in the platforms or in conduits or cable ducts in or on station buildings or other structures as nominated in the design.

- Exposed conduits or cable ducts shall be made as unobtrusive as possible and painted to blend with the supporting structure.

#### 5.11.5.7 Platform and concourse indicators

Cabling to platform and concourse indicators shall be run in the manner specified for guard's indicators.

#### 5.11.5.8 Station buildings

Cables to station buildings for local signalling control panels, telephones, etc. shall be run in the manner specified for guard's indicators.

#### 5.11.5.9 Traffic huts

The foundations for and cabling arrangements to traffic huts shall be constructed as detailed in the design with cable entries built in to suit the cabling requirements and site conditions.

#### 5.11.5.10 Post mounted telephones

Telephone mounting posts and associated cabling shall meet the following requirements:

- The telephone shall be mounted 1250 - 1400mm above ground level on a suitable metal post.
- A suitably drained, graded and level surface shall be provided for persons using the telephone. Where the telephone is immediately adjacent to the danger zone, a galvanised steel pipe railing shall be provided between the telephone and the danger zone.

## 5.12. Associated civil works

### 5.12.1. Minor building works

Minor building works shall be undertaken in accordance with the requirements of CRN CS 330.

The following additional requirements apply:

- Concrete (both ready mixed and site mixed) and stabilised sand shall be produced in accordance with the requirements of AS1379.
- Concrete strength at 28 days shall be not less than 20 MPa. Concrete additives shall not be used without approval.
- All concrete structures and pathways shall be appropriately reinforced with welded rust free steel mesh in accordance with appropriate Australian Standards for the calculated loadings.
- Reinforcement shall be placed and tied (and/or welded) in accordance with the design drawings.

- Internal concrete surfaces shall be free of voids and steel trowelled to a smooth finish.
- External concrete surfaces shall be finished to a non-slip wood trowelled finish.
- Concrete edges and corners shall be chamfered to minimise chipping and breaking.
- Concrete surfaces shall be level except where a slope is required to form a ramp or to disperse water away from a building or other structure.

## 5.12.2. Railway access roads

Where railway access roads are required they shall be constructed in accordance with the requirements of CRN CS 410.

Where cable routes cross a railway access road the following requirements apply:

**For buried cable route**

- buried cables shall be installed at a depth of 800mm unless otherwise approved in the design.

**For above ground troughing route**

- the cables shall be run in buried pipes with pits each side of the roadway, generally in accordance with Section 0.

**For a GLT route**

- the cables shall be run in buried pipes with pits each side of the roadway, or
- the GLT may be laid 150mm below ground and be protected with a reinforced concrete slab.

## 5.12.3. Fencing and gates

The placement and design of boundary fencing and access gates, including any modifications necessary to provide new access ways, shall meet the requirements of CRN CS 510.

## 5.12.4. Bollards

Bollards shall be provided where specified in the design to protect specifically identified items of CRN infrastructure.

The bollards shall be:

- constructed of 100mm nominal bore *heavy* galvanised steel pipe to AS 1074,
- supplied with steel caps fitted,
- concreted one (1) metre into the ground using 6 bags of ‘readymix’ concrete or an approved equivalent

- installed at least 1.2 metres above ground level, and
- be finished with 2 bands of class 1A tape that complies with AS1906.2 such as 3M tape (product code 983-10) 3M brand reflective tape separated 100mm between tapes.

### 5.12.5. Retaining walls

Where retaining walls are required they shall be designed and constructed in accordance with the requirements of CRN CS 330. Retaining walls shall be provided where:

- The top of the location case concrete slab foundation is below the adjacent ground level.
- The top of the signal post foundation is below the adjacent ground level.

# 6. Installation requirements

## 6.1. Cable route: general requirements

- To avoid the need to re-open cable trenches, main and local cables shall be installed in buried cable areas at the same time.
- Existing high voltage earthing arrangements shall not be disturbed under any circumstances.

## 6.2. Installation of GLT

### 6.2.1. Lids

- Where the laying of cables is being undertaken at the same time as the installation of the GLT, the GLT lids shall be installed after all the cables are laid, otherwise the lids shall be fitted as the GLT laying progresses. The GLT shall be thoroughly cleaned prior to installing lids.
- If the GLT is in the vicinity of pedestrian walkways etc., the lids shall be fitted as the work progresses and reopened when required for cable laying.

### 6.2.2. Sealing of entry points

- After the cables are laid all cable entry points to GLT shall be sealed with a sand cement mixture or another compound approved by the Principal Signal Engineer to prevent the entry of rodents and vermin.

# 6.3. Excavation, boring, backfilling and compaction

## 6.3.1. Excavation

All excavation works in the CRN rail corridor shall be undertaken in accordance with the requirements of CRN CS 540.

The following additional requirements apply:

- Mechanical digging or boring machines shall not be used for excavation within
  - 2 metres of high voltage cables, or
  - 1 metre of other existing underground services
- Excavation within 2 metres of high voltage cables or within 1 metre of other existing underground services shall be performed using hand tools, non-destructive excavation or vacuum excavation methods.
- Explosives shall not be used.
- The selected cable route shall be cleared and levelled only to the extent necessary to permit trenching and access for plant/vehicles.
- Any debris, excess soil and/or rock shall be removed from site.
- Levelling work shall not adversely affect railway or natural drainage, or pedestrian or vehicular access routes or create un-drained areas.
- Excavations shall be to the minimum width and depth necessary to best carry out the work in accordance with the design
- The bottom of trenches shall be level and even, free from stones, sharp objects etc.
- All trenches shall be shored to comply with the requirements of the Work Health and Safety Act 2011 and CRN CS 540.
- Excavation work shall not commence in or near tracks, platforms or access roads until sufficient shoring material is available on site to shore up the excavations as the work progresses.

## 6.3.2. Placement of spoil

- Spoil shall be placed in accordance with the requirements of CRN CS 540.
- Spoil shall not be placed in a position where it may damage or affect the operation of existing equipment (e.g. mechanical signalling control rodding or wires, cable routes, power operated points, Emergency Equipment housings etc.).
- Driver's safe and unrestricted access to signal telephones shall be maintained at all times.

### 6.3.3. Protection of trenches

- Trenches shall remain are open for a maximum of three working days except for:
  - trenches under or within 3 metres of operating tracks, or
  - where the stability of the embankment and or formation is affected, or
  - through sidings
- Trenches kept open overnight shall be shored to prevent any movement of surrounding ground under any weather conditions and covered with rigid protective sheeting capable of supporting a 120kg point load without deflection of failure to protect any persons in the vicinity from falling into the open trench.

### 6.3.4. Public Safety

- Where interface sites exist the safety of the public is paramount. Suitable barricades shall be erected around excavations, or covers across excavations where continuous access is required across them, when work is not actually taking place. Barricades shall have a minimum height of 1000mm and barricades and covers shall comply with the Work Health and Safety Act 2011.
- Excavation on platforms shall cause the minimum interference and risk to the public and train operations. Temporary covers shall be provided for trenches to allow access to trains, platform amenities and booking offices. At no time while train services are running shall access to or from the platform to any part of a train be blocked.
- Excavated material shall not be stockpiled on platforms unless agreement is reached with the local station manager.

### 6.3.5. Proximity to existing services

- When trenching alongside or across gas, water mains or service utility lines, work shall be undertaken:
  - in compliance with any restrictions that may apply to the easement and,
  - In accordance with any agreement reached with the owners of that easement regarding methods of protection and support for the services.
- When excavation or trenching must be carried out within 500mm of existing services, the services shall be carefully exposed and protected in accordance with instructions from the owner of the buried service.
- The service shall be inspected with the buried service owner at the completion of the work to ensure that no damage has occurred and the buried service is operating correctly.

## 6.4. Backfilling

- Trenches and other excavations shall not be backfilled until the cable installation has been inspected and approved.
- Backfilling shall be in accordance with CRN CS 540.
- Pipes and cables shall be encased in clean fill to 50mm above the uppermost pipe or cable.
- Backfilled trenches shall be free of depressions and erosion. Any depressions caused by settlement or erosion of the backfilling shall be corrected and the cause of the any erosion shall be rectified.

## 6.5. Compaction

Compaction shall be in accordance with CRN CS 540.

The first 150mm of fill over cover strips or pipes shall be carefully compacted to ensure that the cover strips / pipes are not disturbed.

## 6.6. Underline crossings (ULX)

Underline crossings (ULX) shall be installed in accordance with CRN CS 540.

## 6.7. Cable and pipe ploughing

Cable ploughing shall be undertaken using approved methods. The requirements for approval are detailed in Appendix 2.

The following requirements shall apply.

**Preparation of route**

The cable route shall be prepared to permit the continuous ploughing of each drum of cable and pipe. Cable route preparation shall include:

- Grading and benching of the route as required enabling the cable and piping to be buried at a constant depth.
- Drilling of rock to enable the ground to be ripped.

**Cable installation**

- Cables and pipes shall be installed within a tolerance of ± 50 mm of the nominal depth subject to the minimum cover not being less than the design depth.
- Communications cable shall be separated as required by the design documents and HB 29 2007 and shall be placed above other cables.

- Ploughing of cables across sealed or unsealed public roads and sealed private roads is not permitted. Ploughing across unsealed private roads may, however, be permitted with prior approval from the land / road owner and the Principal Track and Civil Engineer.
- Ploughing will not be permitted within 900 mm of any water, electrical or communications service or within 1500 mm of any gas service or other service carrying dangerous or flammable materials.

**Restoration**

The ploughed route shall be restored as near as reasonably possible to its original state. This may include ground stabilisation and cross drainage, where required, to reduce soil erosion.

Restoration work shall include:

- Removal of large rocks brought to the surface during ploughing.
- Nominal compaction of material left above ground.
- Mechanical compaction of the top 300mm of the ploughed trench in areas where scouring may occur along the main cable route or emergency off-road vehicle access is likely.
- Leaving a small windrow along the cable route.
- Minimum backblading to reduce erosion problems.
- Grass seed distribution where of benefit in reducing erosion or restoring appearance.

## 6.8. Buried pipes

Except for directionally bored ULX's and URX's, pipes shall be laid parallel and level in a consistent format in the trench and secured in that position.

All spare pipes shall be tested for correct diameter by pulling a plug of a diameter 90% of the internal pipe diameter through the pipe after installation, backfilling and compaction.

Spare pipes shall be cleaned, fitted with a stainless steel draw wire suitably anchored at each end of the pipe and then sealed with proprietary end caps to prevent the ingress of dirt, etc.

## 6.9. Cable installation in ladders

The cables shall be installed neatly in the cable tray and shall be laid in such a manner that the need for cables to cross other cables is minimised.

## 6.10. Spare capacity in piped URX/ULX

Spare pipes shall be cleaned, fitted with a stainless steel draw wire suitably anchored at each end of the pipe and then sealed with proprietary end caps to prevent the ingress of dirt, etc.

## 6.11. Gantry foundations

At the completion of gantry foundation installation, the foundations shall be backfilled and surplus material removed in accordance with the requirements of CRN CS 540.

## 6.12. Cable installation

### 6.12.1. General

- Cables shall not be installed without approval. Cable routes will be inspected and approved prior to installation of the cables and again after cable installation and prior to backfilling of trenches or fitting of lids, as applicable.
- Communications cable shall be installed under the direct supervision of an Austel licensed person and in accordance with HB 29 2007.
- Cables shall not be placed in any position, prior to laying, where they may be run over by vehicles or other machinery or where they are laying on sharp objects or over sharp edges. If a cable is run over at any time or otherwise damaged, then that cable shall be replaced before it is laid into the trench or troughing.
- Cables shall be laid neatly, flat and parallel in trenches and troughing. Special care shall be taken at bends or corners in the cable route and at entries into relay rooms and equipment buildings to prevent the interlocking or bunching of cables.
- Cables shall not be overstressed or otherwise damaged during installation.
- In buried cable route, ULX or URX, cables shall be laid in the order specified in the design.
- Pipes shall be sealed immediately following cable installation.
- Cables shall be arranged to permit easy access for the installation of additional cables in the future.
- Lids and covers shall not be fitted until the cable installations have been inspected and approved.
- Lids and covers shall not be fitted until the cable installations have been inspected and approved.

### 6.12.2. Length of cables

- Sufficient length shall be allowed on the cable ends for the cables to be run to their final destination and be terminated.
- Ends of cables (excluding fibre optic cables) to be jointed shall overlap a minimum of one (1) metre.

- Ends of fibre optic cables shall overlap a minimum of five (5) metres. In areas of poor access, additional cable overlap shall be provided.
- Joints in cables shall be kept to an absolute minimum.
- There shall be no joints in cables under rivers, creeks, flood prone areas, under roads or railway tracks, in buildings, in tunnels or within 10 metres of any earth mat. Cable lengths shall be arranged accordingly and cable termination boxes provided where necessary.
- Un-terminated ends of all cables shall be neatly coiled and securely fixed to prevent damage.
- Un-terminated cables ends shall be sealed with approved heat shrink end caps to prevent the ingress of moisture before and after the cables are laid.

## 6.12.3. Protection of cables during installation

Laying of cables shall only be undertaken using approved methods.

The following requirements shall be met in any approved method:

- The limits of the mechanical properties of the cables as specified by the cable manufacture, particularly the maximum tensile rating, the maximum twist, the crush and impact resistance and the recommended minimum bending radius of each cable, shall not be exceeded.
- During cable pulling, cable drums shall be supported on a horizontal shaft and turned by manually or mechanically rotating the drums to feed out the cable.
- Drums shall not be rotated by pulling the cable.
- Cables shall not be flaked off the drum under any circumstances.
- Cables shall be fully supported clear of the ground and other cables during pulling operations by the use of cable rollers or other approved means.
- Pipes into which cable is to be hauled shall be proven for adequate bore and cleanliness prior to cable installation by drawing a test mandrel 240mm long and 90% of the nominal internal diameter of the pipes through the pipes prior to cable hauling.
- "Polywater" or equivalent approved lubricant shall be used to lubricate all cables being hauled through pipes or conduits.
- Cable shall not be laid on or pulled over any projection, edge or corner or subjected to any localised compression.
- When pulling cable through pits, rollers or guides shall be used to prevent the cable from rubbing on the ends of conduits, pipes or on concrete surfaces.

When installing optical fibre cable:

- Extreme care shall be exercised in handling as tension, crushing, kinking and bending outside the limits will cause irreparable damage to the optical fibres.
- Optic fibre cable shall be fitted with hauling eyes. When the cable requires hauling a minimum twist draw rope shall be fitted to the hauling eye via an approved swivel. Connection to the cable by any other means will not be permitted.
- A flexible tube shall be used for protecting and leading the optic fibre cable down to a duct entrance.

### 6.12.4. Labelling of cables

A form of permanent and unique identification (as nominated in the design) shall be applied to both ends of every length of cable. This shall be as near as possible to the ends of the cables but clear of any part that may be trimmed off when the cables are terminated.

The cable identification shall remain clearly legible for at least three years after installation with complete exposure to the elements. Identification shall be clearly visible when installation is complete.

### 6.12.5. Sealing of cable entries

Following the installation of cables, all cable entries to location cases and small buildings shall be sealed. The seal shall be constructed using a re-enterable fire resistant material as nominated in the design such as a sand cement mixture and NOT expanding foam.

## 6.13. Testing of cables

### 6.13.1. General

All cables shall be tested on the drum before laying to ensure compliance with the cable specification.

The cable ends shall be recapped (using heat shrink end caps) after testing unless such ends are located inside weather proof buildings or location cases and the cable ends are not laying on the floor or in cable trenches in relay rooms.

### 6.13.2. Cables with copper conductors

Cables with copper conductors shall be continuity and insulation tested in accordance with the requirements of CRN SC 007 to CRN SC 013 inclusive.

### 6.13.3. Optical fibre cables

Optical fibre cables shall be tested in accordance with Standard Specification 816F.

### 6.13.4. Test records

Test results shall be maintained as part of the quality records.

## 6.14. Temporary fences

Where an existing fence is being replaced or modified temporary fencing shall be erected to prevent unauthorised access to CRN's property. The temporary fence(s) shall be reinstated prior to completion of each day's work.

# 7. Removal of redundant material, equipment and surplus spoil

All redundant signalling and associated communications equipment shall be removed from the work area. Re-useable equipment shall be stockpiled at locations nominated by UGLRL and the remainder of the recovered equipment shall be disposed of.

## 7.1. Reclaimable equipment

Redundant material and equipment nominated by UGLRL for reclamation and reconditioning shall be moved to a location specified by UGLRL.

All redundant material not nominated by UGLRL as being required for reclamation or reconditioning shall be removed from site.

## 7.2. Equipment and materials to be removed

Where equipment and foundations are to be removed, their removal shall comply with the requirements of CRN CS 410.

The equipment to be demolished and removed shall include but not be limited to:

- disused cable,
- AC, GRC and steel troughing and supports,
- cupboards and location cases,
- signals, signal gantries,
- ground frames, releasing switches,
- communications facilities,
- walk-in enclosures and buildings,
- redundant fencing material,
- unsuitable backfilling material and surplus spoil.

Water, sewerage and gas services, where applicable, shall be disconnected and sealed in an approved manner.

Disconnection of electricity supplies shall be arranged by UGLRL and no demolition work shall commence until disconnection is confirmed.

Signal gantries and all attachments thereto shall be removed to foundation level. Signal gantry foundations shall be removed to a depth of 200mm below the immediate adjacent ground level.

Equipment post footings, troughing route post footings and other similar small footings up to 600mm deep shall be removed completely.

Concrete slabs shall be removed entirely. Perimeter footings shall be removed to at least 500mm below ground level.

All depressions and excavations, resulting from the removal of redundant buildings and equipment, shall be filled and compacted to the levels of the surrounding ground. The backfill used shall be consistent with the surrounding ground.

Redundant material and spoil to be removed from the CRN's property shall be tipped or otherwise disposed of at an approved location.

# Appendix A Buried services search procedure

Refer to:
UGLMS-1655521379-431Excavation and Trenching Procedure and related documents

## A.1.1 Aim

- To ensure that the correct procedures for identifying the location of all buried services within the CRN rail corridor have been carried out before commencing any excavation, trenching, boring or grading working.
- To avoid interference or contact with all buried services in the CRN rail corridor.

## A.1.2 Prior to works being undertaken

An “Excavation and Trenching Permit” shall be completed and submitted to UGLRL as part of the cable route design process, and in all cases a minimum of three weeks prior to the planned date for any excavation, trenching, boring or grading works.

No excavation, trenching, boring or grading work shall commence until UGLRL has issued a fully authorised “Excavation and Trenching Permit”.

UGLRL personnel may need to conduct a site visit with the requesting parties to clarify any uncertainty, and to specifically identify particular hazards or features at a given location or locations.

All personnel involved in the excavation, trenching, boring or grading work shall be fully briefed on the contents of the “Excavation and Trenching Permit”, including all conditions and caveats listed. All personnel must sign onto the permit prior to works commencing.

## A.1.3 When undertaking works

If, during excavation works buried services become exposed and damaged they shall only be rectified by personnel who have Engineering Authority to carry out these works. All other persons shall not touch or interfere with exposed and damaged buried services. Work in the vicinity shall cease until repairs have been completed and approval to continue is given.

Cable route markers shall be installed as per Section 5.4.9.

## A.1.4 Updating of signal cable records

Following the completion of the excavation, trenching, boring or grading work the local Signal Engineer shall arrange for the signal cable records be updated.

# Appendix B Cable ploughing approval requirements

## B.1.1 Requirements

Any method proposed for the installation of buried cables by shall be capable of meeting the following requirements:

- The maximum load on the cables shall be less than 75% of the maximum tensile load recommended by the cable manufacturer.
- The maximum tensile load of optical fibre cable shall not exceed 1.3KN.
- The cables or pipes shall be fed off the drums using mechanical means.
- Immediate automatic detection protection against overstress of the cable is provided.
- Where the cable or pipe undergoes a change in direction during the ploughing operation, mechanism shall be provided to prevent damage to the cable and pipe.
- The size of the roller/tray and feed tube shall be such that the radius bend in any cable is not less than the manufacturers recommended minimum radius bend for the largest cable being ploughed.
- The cable can be removed from the ploughing apparatus without box is attached to the tine and can be opened to enable the cable to be removed from the box without the cable being cut.
- Cables and pipes are able to be installed within a tolerance of ± 50 mm of the nominal depth subject to the minimum cover not being less than the design depth.
- Vibratory ploughing, which uses vibrating motions as well as draw bar pull to bury cables, shall not be used.

## B.1.2 Approval

In order for a method to be approved the following requirements shall be met:

- The proposed equipment and work method shall be documented and submitted to UGLRL for approval
- The proposed work method shall be demonstrated as follows:
    - Cables shall be ploughed over a 100 metre test section using the proposed work method.
- Tests will be carried out on this section of cable route including:

- A longitudinal stress test to determine that the cable has been laid without excessive stress.
- Cable route preparation test to determine if the cable route has been adequately prepared.
- Cable position test to determine the accuracy of the location of the ploughed cable and pipe.
- Testing to determine that no physical damage has occurred to the cable cores or insulation or to the pipe.

- Completion of the tests to the satisfaction of UGLRL shall be a requirement for approval.

# Appendix C Signal cable route marker drawing – M05-049-CRN